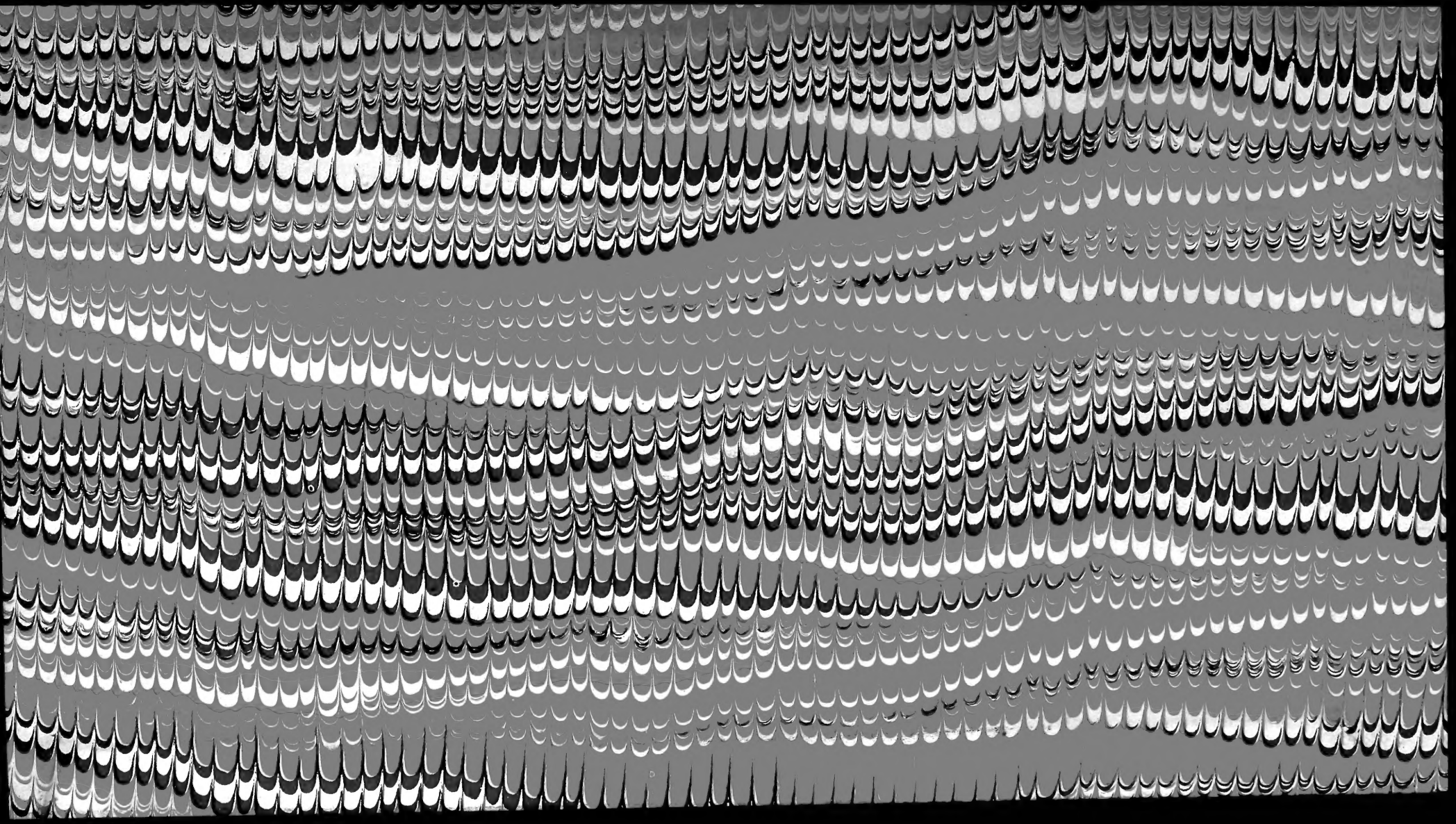

Education Department Bulletin

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No. 465 ALBANY, N. Y. FEBRUARY 15, 1910

New York State Museum

JOHN M. CLARKE, Director
EPHRAIM PORTER FELT, State Entomologist

Museum Bulletin 136

CONTROL OF FLIES

AND

OTHER HOUSEHOLD INSECTS

BY

EPHRAIM PORTER FELT Sc.D.

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
1910

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SIR: In April of last year I communicated to you a bulletin by the State Entomologist entitled the *Control of Household Insects.* This publication, which was issued to a considerable edition, has been entirely exhausted and the demand continues. To meet this outstanding demand for knowledge in regard to household insect pests, I transmit to you herewith the manuscript for a new edition of this work, enlarged in its scope, and recommend its publication as a bulletin of the State Museum.

Very respectfully
JOHN M. CLARKE
Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 26th day of January 1910

Commissioner of Education

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CONTROL OF FLIES

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INTRODUCTION

The discovery that the common house fly may, under certain conditions, play a most important part in the dissemination of tuberculosis, typhoid fever and other diseases of the alimentary tract, has effected in recent years a marked change in the attitude of the public toward this very prevalent nuisance. This statement should not be construed as meaning that the common house fly is necessarily the principal agent in disseminating the above mentioned diseases, though it would not be surprising, were we fully acquainted with the facts, to find that this familiar and almost universally tolerated species has been much more active in this respect than hitherto suspected. An insect, breeding as does the house fly upon organic matter, and feeding indiscriminately upon material which may be literally swarming with deadly germs, and other substances likely to be used as food, can hardly be regarded as other than a menace to human life and happiness.

Recent discoveries respecting the part played by insects in the dissemination of malaria, yellow fever and typhoid fever, read like a romance. Mosquitos as distributing agents of malaria have

been suspected for many years. An active impetus was given to this suspicion through the discovery by Ross that certain Indian mosquitos harbored a malarial parasite affecting birds. It was only a step from this to human malaria. The mosquito-malarial theory took such firm hold that in 1900 Drs Low and Sambon spent the summer on the fever-ridden Roman campagna, relying entirely for protection from malaria upon flimsy mosquito netting. Their field test was further confirmed by the shipment of malarial-infected mosquitos to London, where they were allowed to bite Dr Patrick Manson's son, who in due time came down with the disease though residing in a nonmalarious section.

The deadly, justly dreaded "yellow jack" has likewise been traced to its lair through the heroism of a few devoted scientists. Volunteers lived in a fever-stricken locality with no protection from infection other than the frail mosquito bar. They even slept in beds soiled by fever patients for the sake of demonstrating beyond question that the disease was not infectious. Drs Carroll and Lazear went further and allowed themselves to be bitten by infected mosquitos. Both contracted the disease, the latter losing his life on the altar of scientific investigation. This was true heroism. All honor to these martyrs. Theirs was not a useless sacrifice. Before their time, a yellow fever outbreak meant the loss of hundreds or thousands of lives, simply because there was no known adequate method of preventing the disease. Prolonged, arbitrary and wasteful quarantines were maintained. Thousands fled from infected districts. The horrors of the shotgun quarantine prevailed. The control of the yellow fever epidemic of 1905 in New Orleans is a most striking testimony to the value of the recent discoveries regarding this disease. This outbreak was handled as a mosquito-borne infection and for the first time the disease was stamped out before cold weather and with comparatively little loss in either life or property.

DISEASE CARRIERS

Typhoid or house fly[1]

The typhoid or house fly is such an extremely common species that a detailed description is almost unnecessary. Dr Howard's investigations show that fully 98% of the flies in houses are ordinary house flies. A few others are associated with this very

[1]Musca domestica Linn.

prevalent nuisance. The stable fly[1] may be rather abundant about houses in the fall and is responsible for the persistent belief that under certain conditions the house fly bites. Invariably the offender is this inhabitant of the barn, a form which presents an extremely close general resemblance to the fly and is perhaps best recognized by its bite. Another fly liable to be abundant about houses in the fall is known as the cluster fly[2] a species somewhat larger than the house fly and easily recognized by the yellowish hairs upon the thorax. The small, yel-

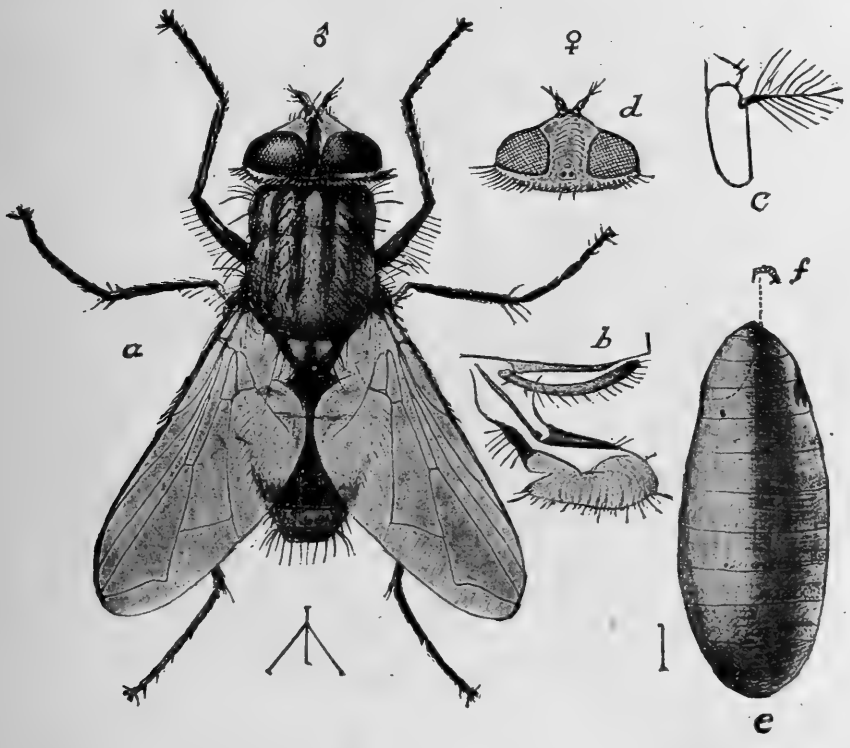

Fig. 1 Typhoid or house fly ; *a*, male, seen from above ; *b*, proboscis and palpus from the side; *c*, tip of the antenna; *d*, head of female ; *e*, puparium ; *f*, the anterior breathing pore or spiracle, all enlarged. (After Howard & Marlatt, U. S. Dep't Agric. Div. Ent Bul. 4 n. s. 1896)

lowish fruit fly,[3] only about 1/8 of an inch long, is sometimes rather abundant in houses and is invariably found in association with overripe or decaying fruit. These species, though annoying and under certain conditions dangerous, are insignificant offenders compared with the common house fly.

Description. The egg of the house fly is a slender, whitish object grooved on one side somewhat like a grain of wheat and only 1/20 of an inch long.

[1] Stomoxys calcitrans Linn.
[2] Pollenia rudis Fabr.
[3] Drosophila ampelophila Loew.

The maggot, or more properly larva, is invariably whitish at first, very small and when full grown only about 1/3 of an inch long. The body tapers from the large, nearly truncate posterior extremity to the slender head.

The resting or transforming stage known as the puparium, is oval, brownish, ringed and scarcely 1/4 of an inch long.

The parent insect or adult fly is about 1/4 of an inch long, rather slender, dull grayish and therefore easily distinguished from the stouter, metallic blue or green bottle flies occasionally seen in houses and especially about meats.

A disease carrier.[1] Typhoid fever is one of the most serious ailments to which man is subject. There are about 500,000 cases of this disease annually in America, about 50,000 proving fatal. 60% of the deaths in the Franco-Prussian War and 30% of the deaths in the Boer War were caused by this disease. Dr M. A. Veeder of Lyons in 1898, was very strongly of the opinion that the house fly was largely responsible for the dissemination of this disease in camps. Dr Walter Reed writing of an outbreak near Porto Principe in the annual report of the War Department states that the outbreak "was clearly not due to water infection but was transferred from the infected stools of patients to the food by means of flies, the conditions being especially favorable for this manner of dissemination." Dr Vaughan, a member of the army typhoid commission, writes as follows respecting conditions in the Spanish-American War:

27 Flies undoubtedly served as carriers of the infection.

My reasons for believing that flies were active in the dissemination of typhoid may be stated as follows:

a Flies swarmed over infected fecal matter in the pits and then visited and fed upon the food prepared for the soldiers at the mess tents. In some instances where lime had recently been sprinkled over the contents of the pits, flies with their feet whitened with lime were seen walking over the food.

b Officers whose mess tents were protected by means of screens suffered proportionately less from typhoid fever than did those whose tents were not so protected.

c Typhoid fever gradually disappeared in the fall of 1898, with the approach of cold weather, and the consequent disabling of the fly.

It is possible for the fly to carry the typhoid bacillus in two ways. In the first place fecal matter containing the typhoid germ may adhere to the fly and be mechanically transported. In the

[1]For a bibliography of flies and disease, see N. Y. State Mus. Bul. 134, 1909. p. 32–40.

second place, it is possible that the typhoid bacillus may be carried in the digestive organs of the fly and may be deposited with its excrement.

Dr Alice Hamilton in 1903, studying the part played by the house fly in a recent epidemic of typhoid fever in Chicago which could not be explained wholly by the water supply nor on the grounds of poverty or ignorance of the inhabitants, captured flies in undrained privies, on the fences of yards, on the walls of two houses and in the room of a typhoid patient and used them to inoculate 18 tubes, from five of which the typhoid bacillus was isolated. She further found that many discharges from typhoid patients were left exposed in privies or yards, and concluded that flies might be an important adjunct in the dissemination of this infection. More recently, Dr Daniel D. Jackson investigating the pollution of New York harbor in 1907 to 1909, found that by far the greater number of cases occurred within a few blocks of the water front, the outbreak being most severe in the immediate vicinity of sewer outlets. He gives a series of charts showing an almost exact coincidence between the abundance of house flies and the occurrence of typhoid fever, when the dates are set back two months to correspond to the time at which the disease was contracted. He is of the opinion that most of the typhoid cases in New York originate in local infections carried by flies. The bacilli of typhoid fever were found by Ficker in the dejecta of house flies 23 days after feeding, while Hamer records the presence of this bacillus in flies during a period of two weeks. It has recently been found that flies produced from maggots living or developing in infected material are capable of conveying disease even when not exposed to subsequent infection. Most significant of all, it should be noted that competent physicians in position to make extended observations upon this disease and the methods by which it may be disseminated, are of the opinion that under certain conditions at least, the fly is a very important factor. Epidemics spread by flies, according to Dr Veeder, tend to follow the direction of prevailing warm winds. He considers flies the chief medium of conveyance in villages and camps where shallow, open closets are used, thus affording the insects free access to infected material, and where it is possible to eliminate water and milk as the sources of infection. Drs Sedgwick and Winslow, writing in 1903 state that " the three great means for the transmission of typhoid fever are fingers, food and flies," the authors holding the last to be the most important.

Typhoid fever, while a most dangerous infection, is not the only disease which may be conveyed by flies. Certain forms of diarrhoea and enteritis are undoubtedly due to specific germs, and there is no reason why the bacilli causing these infections may not be carried as easily and in the same way as those responsible for typhoid fever. The monthly bulletin of the New York State Department of Health for October 1908, states that during 1907 there were in New York State 37,370 deaths of infants under 2 years of age, 9213 being due to diarrhoea and enteritis. Careful investigators, it is stated, have placed the proportion of deaths between bottle-fed and breast-fed babies as 25 to 1. Physicians recognize the necessity of providing pure milk for young children, and in most instances it is comparatively easy to see how flies might be responsible for the major portion of the infections, since they usually occur in numbers about stables, in the vicinity of milk houses, in the neighborhood of milk stations, on milk wagons and, in fact, are found in greater or less numbers wherever milk is stored, excepting in refrigerators and similar places. Martin states that each succeeding year confirms his observation of 1898 to the effect that the annual epidemic of diarrhoea and typhoid is connected with the appearance of the common house fly, while Nash, in the *Lancet,* records no mortality from diarrhoea among infants at Southend during July and August 1902, this immunity being accompanied by the almost complete absence of the house fly. This insect was abundant in that locality in September and coincidently epidemic diarrhoea developed. Sandilands, in the *Journal of Hygiene,* states that the great majority of cases of diarrhoea are due to the consumption of infected food, and suggests that the seasonal incidence of diarrhoea coincides with and results from the seasonal prevalence of flies. Dr Jackson of New York records several epidemics of a malignant type of dysentery radiating from a single point and disappearing entirely when proper disinfection of closets was enforced.

The evil possibilities of the fly are by no means exhausted in the above recital. It is well known that flies feed upon sputum. Experiments by Lord recorded in the *Boston Medical and Surgical Journal* show that flies may ingest tubercular sputum and excrete tubercular bacilli, the virulence of which may last for at least 15 days. He considers the danger of human infection from this source to lie in the ingestion of fly specks on food, and suggests

that during the fly season great attention should be paid to the screening of rooms and hospital wards containing patients with tuberculosis and laboratories where tubercular material is examined.

The evidence showing that flies may play an important part in the diffusion of cholera is, according to Dr Nuttall, absolutely convincing. He cites experiments showing that cholera bacilli may be found on flies in large numbers, while they may occur in the dejecta within 17 hours after feeding and as late as four days. Infected flies have been given access to milk and cholera cultures made therefrom.

Dr Nuttall considers that the evidence previously submitted proves that the house fly may carry about and deposit anthrax bacilli, though there may be a question as to how generally flies are responsible for the dissemination of this disease. Parke admits the possibilities of flies distributing, in addition to diseases mentioned above, plague, trachoma, septicemia, erysipelas and leprosy. Furthermore, there are those who would hold flies responsible for the more frequent new cases which occur in the zone immediately surrounding the smallpox hospital and which may be due either to the wafting out of infected particles or their carriage by flies. The latter is considered the more probable. Yaws or framboesia is a tropical infection carried by this household pest. Howe, according to the statement of Dr Howard, has demonstrated that the purulent conjunctivitis of the Egyptians is spread by the house fly. The experiments of Grassi show that the eggs of Taenia, Trichocephalus and Oxyuris pass uninjured through the alimentary tract of flies.

Methods of carrying diseases. The most common and dangerous infections conveyed by the house fly are typhoid fever, other intestinal disorders, including those affecting young children, and tuberculosis. Typhoid germs may be discharged from the human system several weeks before diagnosis is possible, continue in numbers 6 to 8 weeks after apparent recovery, and in exceptional cases may persist during a period of several years. There are authentic records of a patient distributing these germs for 17 years and being the incipient cause of 13 cases during 14 years of that period. Even the urine of patients may contain active typhoid bacilli. Furthermore, Dr M. A. Veeder of Lyons cites a case where typhoid fever was perpetuated from year to year in a locality, ascribing it to a physician recommending the burial of all typhoid excreta and the

execution of this direction by a favorite nurse. It is well known that soil infected by these germs may be the origin of new cases, and Dr Veeder significantly observes that the annual recurrence of typhoid fever in the above noticed locality ceased with the death of the two parties mentioned above and a change in the method of disposing of typhoid discharges. The germs producing other intestinal disorders are discharged from the system, though presumably not persisting for such extended periods. It is well known that the bacilli causing tuberculosis are abundant in the sputum of patients and are therefore, under the prevalent sanitary conditions, easily accessible to flies.

The house fly subsists entirely upon fluids and feeds with apparently equal gusto upon fresh manure, decaying vegetable matter, sputum or the daintiest culinary preparations. It is only necessary for discharges from patients suffering from typhoid fever or other intestinal diseases to be exposed in open vessels, poorly constructed privies, or even in vacant lots near dwellings in order to secure the spread of the infection. The hairy legs are fouled with thousands of deadly bacilli and countless numbers are swallowed. Shortly thereafter the flies may appear in the house and incidentally contaminate the food, to the great peril of the consumer, with the germs adhering to the limbs and those deposited with undiminished virulence in the familiar fly specks. This, while disgusting and abhorrent to every sense of decency, occurs repeatedly and is apparently ignored by the masses, despite the deadly peril thus incurred. One fly, after having fed upon contaminated matter, may carry many more bacilli than usually occur in gallons of infected milk or water.

Habits. The house fly breeds by preference in horse manure, though it lives to a limited extent in cow manure and miscellaneous collections of filth, especially decaying vegetable matter. The flies deposit their eggs upon manure and similar material, the maggots hatch in less than 24 hours and, under favorable conditions, complete their growth in 5 to 7 days. The white conical maggots some half an inch long then transform to an oval, brown, resting or pupal stage, remaining in this condition from 5 to 7 days. The life cycle is therefore completed in 10 to 14 days, the shorter period being true of the warmer parts of the year, particularly in the vicinity of Washington, D. C. One fly may deposit 120 eggs, and as there may be 10 or 12 generations in a season, it is not sur-

prising that this insect should become extremely abundant by midsummer. It has been estimated that 1200 house flies might be bred from a pound of manure, and at this rate a good load would produce two and one half million. Fortunately, breeding is confined to the warmer months, only a few flies wintering in houses in a more or less dormant condition.

Ordinarily, flies do not travel a great distance and, in most instances, probably breed within 300 to 500 feet of places where they are extremely abundant. Butcher carts, grocery wagons and electric or steam cars carrying more or less exposed meat and other supplies attractive to flies, may become important agents in the dissemination of disease, since it is only necessary for these vehicles to load where conditions are favorable for fly infection and we may have a mysterious outbreak of disease at some distance from the source of trouble.

Natural enemies. The house fly, though so abundant, is subject to attack by various natural enemies. One of the most common is a fungous disease known as Empusa muscae which is occasionally responsible for the death of many flies, particularly toward the end of summer. It is not uncommon to find a few individuals affected by this disease every year. A small, reddish mite may be occasionally found attached to flies, seriously weakening the host. There are, in addition, wasps and spiders which prey upon flies and undoubtedly are of considerable service though they are very rarely sufficiently abundant to materially reduce the numbers of this pest. Another interesting enemy of the house fly is known as the house centipede,[1] a harmless species which, in recent years, has become well established in many houses in New York State. It is credited with preying on house flies, cockroaches and presumably other insect inhabitants of dwellings.

Sanitary measures. The first essential is to prevent the spread of disease by the prompt disinfection of all discharges, both fluid and solid, from typhoid and other fever patients, thus preventing so far as individual cases are concerned, the possibility of fly infection. Such treatment should include all affections where there is even a remote possibility of insects or other agents carrying disease from one person to another. A very cheap and effective disinfectant, according to Dr Veeder, is a strong solution of the common blue vitriol or sulfate of copper, a few pounds being sufficient for a hogsheadful of disinfectant.

[1] Scutigera forceps Raf.

It is hardly necessary to add, in view of the foregoing, that the greatest care should be taken to exclude flies from the sick room, especially in the case of contagious diseases. These pests not only annoy the patient but may aid in carrying the germs to others. Accumulations of exposed fecal matter in the vicinity of human dwellings should not be tolerated, since disease can be easily contracted from such sources. Swill barrels should always be provided with tight covers and care exercised that there be no leakage or accumulation of fly-breeding material about the barrel. The old-fashioned box privy should be abolished unless it is conducted on the earth closet principle and the contents kept covered with lime or dry earth, so as to prevent both the breeding and infection of flies. In this connection it should be remembered that deposits of human excrement in the open are equally dangerous. The modern water-closet and cesspool is by far the best and safest method of caring for these wastes. Such conveniences — one might well term them necessities — are no more costly than a long run of fever with its attendant suffering and occasional death.

It is obviously impossible to distinguish between flies bearing disease germs and others. Consequently, it is extremely desirable to keep these pests from all food, particularly that to be eaten without having been cooked. This is especially true of milk, since it affords a favorable medium for the multiplication of certain disease germs. It applies to dealers in food supplies as well as to the home. A movement for the better protection of food supplies, now being pushed so vigorously by the Consumers' League in New York city, might well be extended to other localities. This important step toward better sanitary conditions would receive an additional impetus if the public refused to patronize provision stores, restaurants and hotels overrun by flies.

Control measures. The foregoing account justifies the assumption that numerous flies may be construed as indicating a nearby and usually easily eliminated breeding place. It should be observed at the outset that these insects multiply most readily in moist, organic matter, preferably in light places, and that at least 10 days are necessary before the life cycle can be completed. Domestic animals are still a necessity, though it does not follow that the manure from stables must be thrown outdoors and allowed to produce myriads of flies throughout the warm months, a condition frequently obtaining in the country. It is not necessary that

this material be stacked for weeks in partly open cellars or back yards connected with village or city stables. Common experience and experiments by the writer show that flies rarely invade darkened places. One of the most fly-beridden situations we chanced across the past summer was an open barn cellar containing a mass of sloppy manure in a hog pen. Such conditions should never be allowed to exist. Manure can and should be stored in a fly-proof receptacle. This may be a tightly covered pit outside the stable or a cellar so dark or so tight that flies will not or can not enter. Both are relatively easy to construct with our modern concrete walls, matched lumber and cheap building paper. Even should eggs be deposited in the manure prior to its being placed in any such receptacle, it would be comparatively easy to provide, at the farther end of such cellar, pit or vault, a tightly screened light fly trap. Any flies issuing from the manure would enter the trap, and comparatively few escape to the stable. It is entirely practical to make similar provision for the care of other fly-breeding materials, such as table scraps, decaying fruit, etc.

Conditions may render it practically impossible to provide such a fly-proof receptacle. Experiments have shown that horse manure treated each morning with a small amount of chlorid of lime will not produce flies. A cheap material which, according to Prof. W. B. Herms of California, may be used for the destruction of the maggots in manure, can be prepared by dissolving one half pound of caustic potash in a half pint of water. Stir the cold solution and at the same time add one quart of linseed oil and stir at about hourly intervals for four or five hours and then allow the mixture to stand over night. Next, add one and one fourth quarts of commercial cresol to the soap formed and dilute the slowly formed solution with 20 parts of water. Three or four days may be necessary to effect a complete solution. Poultry should not be allowed to feed on maggots killed in this manner. It is very probable that some of the so called " soluble " or miscible oils, now on the market under various trade names, could be used for this purpose, the dilution being about one to ten.

It will be seen by referring to the habits of the house fly that it is impossible for this insect to produce a generation inside of 10 days, consequently the frequent removal, at approximately five day intervals, of manure and other fly-breeding material will prevent the multiplication of this insect, provided the work is thoroughly

done. This is entirely practical in many places and in accord with the best agricultural practice. Sanitary regulations of the District of Columbia permit the keeping of manure in barrels, provided it is tightly packed and removed within a certain period. Manure spread upon the field dries out so rapidly that the insects are unable to complete their transformations. The persistence of flies in localities where this practice prevails, means that certain breeding places have been overlooked and, as a rule, the evil can be corrected without great expense. There is no reason why stables and barns on farms in particular, should be located so near the house as to cause serious trouble on account of flies. One or more of the above measures is applicable to every stable in cities and villages and should be practical under most farm conditions.

It will be found in practice that some flies are very apt to exist in a neighborhood even after the adoption of rigid precautions. They should be kept out of houses, so far as possible, by the use of window and door screens, supplemented by the employment of Tanglefoot or other sticky fly-paper, or better yet, a sweetened 5 to 8 per cent solution of commercial formaldehyde. This latter should be renewed from day to day and exposed in saucers or other shallow dishes in places where flies are most abundant. A 40 per cent solution of formaldehyde can be purchased in drug stores, and if diluted with five or six times its volume of water, will give the desired strength; add a little sugar or other sweet. This material is somewhat expensive but much preferable to arsenical or cobalt poisons so extensively used against flies. Fresh pyrethrum powder placed upon window sills has also been highly recommended.

The control of this pest is of great importance to the community. Individual effort in this direction should be strengthened and sustained by all officials charged with protecting the public health. The Health Department of Washington, D. C. has already promulgated excellent ordinances against the fly pest. Similar action should be taken by health officials in our municipalities and villages.

Fruit flies

These light brown flies, only about 1/8 of an inch long, are most commonly found about the pomace of cider mills and on overripe or partly decaying fruit. They are attracted by fermented liquids, such as wine, cider, vinegar, beer, and may frequently be observed on the sides of jars containing preserved fruits. There are two

species[1] which appear to be most abundant. It is very difficult to keep these insects out of houses on account of their small size. Dr Howard has listed these forms as likely to be disease carriers.

These little insects rarely enter the house unless attracted by overripe or canned fruit. The latter should be hermetically sealed, making it safe from injury, and stored in the cellar or other place comparatively inaccessible to the flies, as soon as convenient. These small flies can easily be destroyed with fresh pyrethrum powder.

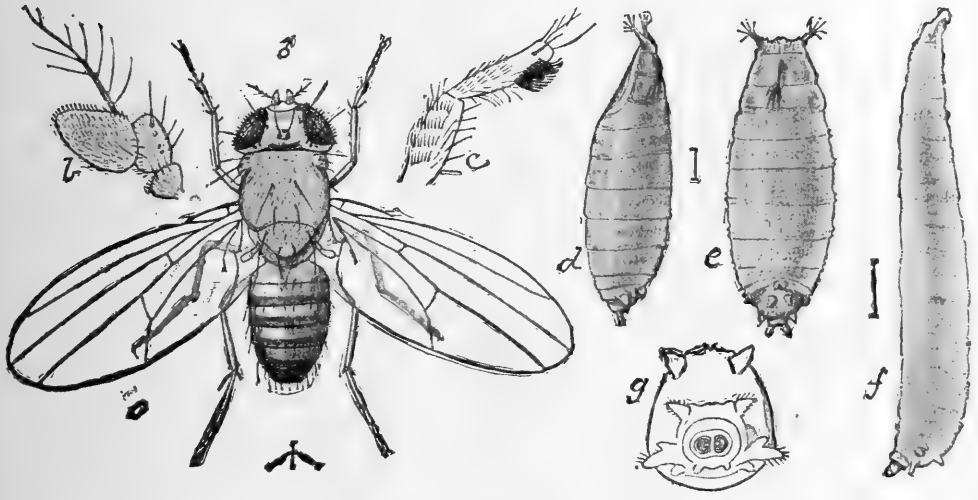

Fig. 2 Fruit fly: *a*, adult fly; *b*, antenna; *c*, base of tibia and first tarsal joint; *d*, puparium, side view; *e*, same, dorsal view; *f*, larva; *g*, anal segment of same; *a*, *d*, *e*, *f*, much enlarged; *b*, *c*, *g*, still more enlarged. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

Malarial mosquito[2]

This is one of our native species. It is only recently that its connection with the spread of malaria has been established beyond question, though there has long been a suspicion that some mosquitos might be responsible for this disease.

Infection by malaria. Medical men, best qualified to pass upon the question, unhesitatingly affirm that certain mosquitos are responsible for the dissemination of this malady. Malaria, like some other diseases, is caused by a specific germ. It is peculiar in that it has to pass through certain changes within the body of the mosquito before it can develop successfully in the human system. Moreover, malarial mosquitos are harmless until they have become infected by biting some person suffering from

[1] Drosophila ampelophila Loew and D. amoena Loew.
[2] Anopheles maculipennis Meign.

this disease. These germs may be carried by man in a latent condition for years. This is especially true of Italians. The sequence of events may be briefly summarized as follows: A female mosquito bites a person having malarial germs in his blood. The malarial parasites enter the walls of the mosquito's stomach, undergo certain changes therein, and in from 7 to 14 days make their way to the salivary glands and are then ready to enter the system of the next person bitten. These germs then undergo a series of changes, and if the person is not immune a more or less severe case of malaria develops. So far as known, the malarial mosquito, and that only, can carry this infection. The connection between malaria and extensive excavations has long been recognized, though it is only recently that a satisfactory explanation of this condition has been advanced. Malarial mosquitos breed in large numbers in pools in and about excavations. Italians are our principal excavators. Most of them have suffered from malaria and have the disease germs

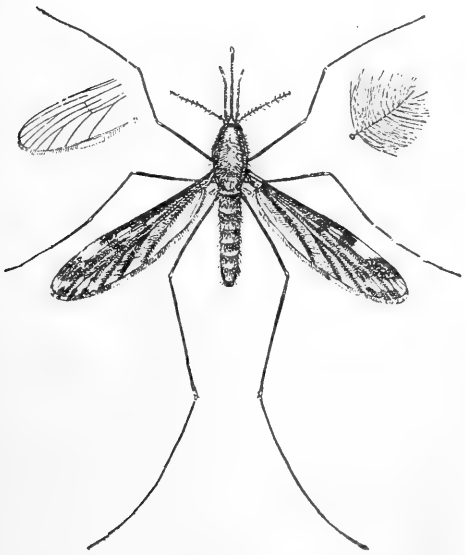

Fig. 3 Malarial mosquito, female, with male antenna at right and wing tip showing venation at left. (Reduced from Howard, U. S. Dep't Agric. Div. Ent. Bul. 25. n. s. 1900)

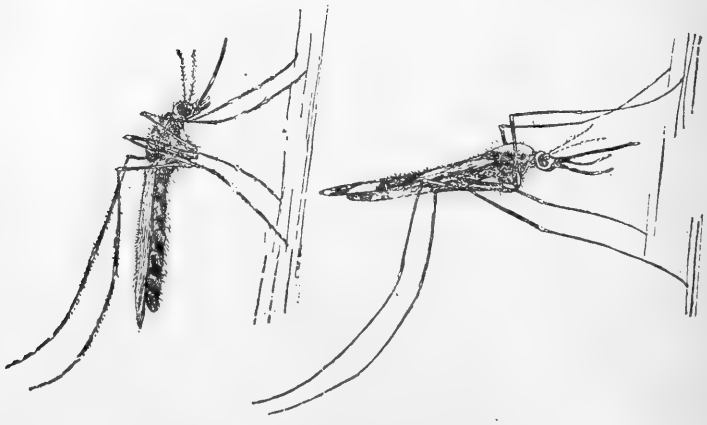

Fig. 4 Common and malarial mosquitos at rest, the latter to the right. (Reduced from Howard, U. S. Dep't Agric. Div. Ent. Bul. 25. n. s. 1900)

in their systems. The malarial mosquito, breeding in large numbers about recent excavations, derives its infection from the Italians and then, if opportunity allows, inoculates Americans. We

therefore frequently have exceptionally severe outbreaks of malaria following extensive excavations. This is exactly what would be expected if the above statements are true.

Appearance and habits. The appearance and habits of the malarial mosquito are important if we wish to avoid malaria. This peculiar form is easily recognized by its spotted wings and, in particular by the characteristic resting position, the beak and the body being in almost a straight line and at a considerable angle to the supporting surface. On the other hand, our ordinary mosquitos do not have spotted wings and when at rest the beak and the body form an obtuse angle, the body being approximately parallel with the supporting surface. The wriggler of the malarial mosquito occurs in grassy pools, beside streams and is frequently very abundant in collections of water in and about recent excavations. The wriggler of the malarial mosquito is easily recognized by the absence of a conspicuous air tube, by its resting in a horizontal position just beneath the surface film, and the usually bright or dark brown and greenish colors. The wrigglers of the common mosquito, conversely, have a large air tube at the posterior extremity, invariably rest with the body at a considerable angle to the surface of the water and are a dull whitish or yellowish white. The malarial mosquito breeds more or less during the warm months of the year, the spotted-winged adults wintering in any shelter, frequently in houses and occasionally flying in midwinter. The capture of chilled specimens on snow banks in early spring is not unusual.

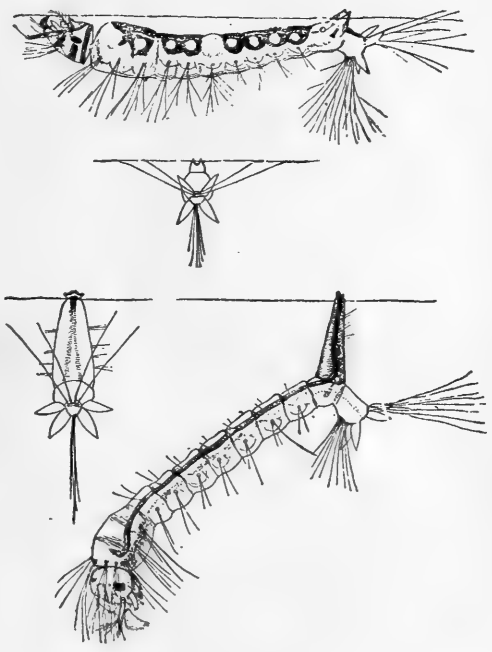

Fig. 5 Characteristic feeding position of malarial mosquito wriggler in upper figure, and that of the common mosquito in lower figure. (Reduced from Howard, U. S. Dep't Agric. Div. Ent. Bul. 25. n. s. 1900)

Control measures. Malarial outbreaks may be prevented or controlled in two ways. The malarial mosquito is very local in its habits. It is comparatively easy, by draining breeding pools and treating those not easily drained, with oil, to eliminate the mosquito and thus do away with all danger of infection. This is

practicable in most cases and in sections where malaria is more or less prevalent, is the only course to pursue.

The malarial mosquito is widely distributed in the North and there is always a chance of an outbreak following the appearance of parties suffering from malaria or having the parasite in their blood, as for example, Italians. The advent of either in a neighborhood should be preceded if possible by extraordinary activity in draining or treating breeding places in order to destroy as many of the insects as possible and thus reduce the danger of infection. Methods of value in controlling common mosquitos will be equally serviceable in checking this disease carrier.

Yellow fever mosquito[1]

This, though a southern species, is of interest owing to its great economic importance. It is a dark brown form, marked with strongly contrasting silvery white, and is frequently designated as the day mosquito in the South.

Yellow fever carrier. This insect appears to be the only agent by which yellow fever may be conveyed from one person to another. As in the case of the malarial mosquito, the yellow fever mosquito is harmless until it has become inoculated with the germs by biting a yellow fever patient, and even then some 12 days must elapse before it can convey the infection. As a result of the recent discoveries relating to this insect, the control of a yellow fever outbreak means a strenuous, well sustained campaign against mosquitos, supplemented by the exercise of special care to prevent their gaining access to yellow fever patients.

Habits and control. The yellow fever mosquito appears to have in the South much the same habits as our house mosquito in the North. It displays a marked preference for the water in cisterns, tanks and similar places; consequently measures of value in reducing the house mosquito will prove equally serviceable in controlling this much more dangerous southern species.

Bedbug[2]

The brown, oval, flattened, malodorous insect so generally designated by the above name, is too familiar to require description. It is especially likely to be abundant in old houses where cracks and crevices abound, and its continuance therein is favored by

[1] Stegomyia calopus Meign.
[2] Cimex lectularius Linn.

the old style wooden bedstead with its numerous shelters. The occurrence of this pest in a home is not necessarily a reflection upon the ability of the housewife. Its continuance there may be the occasion of grave reproach. Bedbugs are very liable to occur on boats, are occasionally found in sleeping cars and are said to be much more common in the Southern than in the Northern States. This pest has been connected with the dissemination of several diseases.

Habits. This insect, as many can vouch for by personal experience, is nocturnal in habit. Recent experiments show that it may feed under certain conditions on mice as well as upon man. This

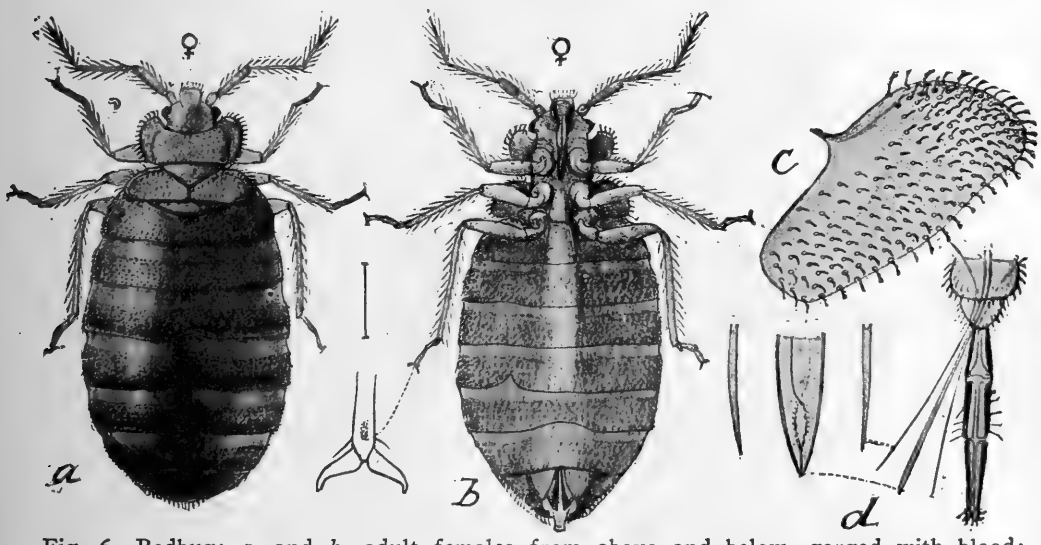

Fig. 6 Bedbug: *a*, and *b*, adult females from above and below, gorged with blood; *c*, and *d*, structural details. (After Marlatt, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

habit, should it prove to be general, accounts for cases where bedbugs are found very abundant in houses which have been uninhabited for some time. Another species[1] occurs in swallows' nests and occasionally invades adjacent living rooms. It appears to live almost exclusively upon birds, though a third form,[2] found on chickens, has been known to suck human blood, but not under natural conditions.

The oval, white eggs of the bedbug are deposited in cracks and crevices in batches of 6 to 50 or thereabouts. The yellowish white, nearly transparent young hatch therefrom in a week or 10 days. Experiments have shown that about 11 weeks are necessary for the young insects to attain maturity, though the period is probably greatly modified by the degree of warmth and the

[1] Cimex hirundinis Jenyns.
[2] Cimex columbarius Jenyns.

abundance of food. It is said that ordinarily only one meal is taken between each of the five molts preceding the attainment of maturity. Full-grown bugs at least are able to endure long fasts with apparently no inconvenience.

Control measures. Cracks and crevices, loose wall paper and the old wooden bedsteads afford ideal hiding places for this disgusting pest. The modern tight construction of both floors and walls, and iron or brass bedsteads reduce the retreats of this species to a minimum and greatly facilitate its control.

The insect can be controlled in the older type of dwelling only by extreme vigilance. Cracks and crevices should be stopped so far as possible, and the joints of the old-fashioned bedstead treated liberally with benzine, kerosene or similar oils. Hot water can be employed for cleansing bedsteads where this treatment seems preferable. Corrosive sublimate is frequently used, though a deadly poison and should be employed with great caution. The daily inspection and the destruction of bugs found on the bed and bedding soon results in eliminating the pest unless the building affords comparatively inaccessible retreats, as, for example, a very defective floor.

A room badly infested by this pest might well be thoroughly fumigated with brimstone; 2 pounds of sulfur are advised for each thousand cubic feet of space, the treatment being continued at least 24 hours if possible. The sulfur candles now manufactured are excellent for this purpose. A more effective though much more dangerous method is the employment of hydrocyanic acid gas, directions for the use of which are given on page 48. This latter is especially serviceable where entire buildings are badly infested.

It may be comforting to know that the bedbug has active enemies in the little red ant and also cockroaches. Unfortunately these insects are serious nuisances in the household and hardly more welcome than the pest under consideration.

ANNOYING FORMS

Cluster fly

This interesting species[1] has received its popular name because of the large clusters occasionally found in autumn in houses. It is easily distinguished from the rather closely related house fly by the black thorax covered rather thickly with tawny hairs frequently inclining to a grayish shade. The young of this species live about

[1] Pollenia rudis Fabr.

the roots of grasses and there is a record of its having been reared from cow dung. Clusters of this insect can easily be destroyed by dusting the flies liberally with fresh pyrethrum or insect powder. The insecticide may be molded into moist cones and burned if preferred. The stupefied flies, in either case, should be swept up and burned.

Wasps and hornets

The paper wasp[1] and the common wasp[2] frequently occur about buildings and are of considerable service in destroying flies. Occasionally, if exceptionally abundant, they may become a nuisance on account of the danger from stinging. These insects can easily be excluded by the use of screens and in case of their being excessively abundant, the nests should be found and the inmates destroyed at night with chloroform or bisulfid of carbon.

Fig. 7 Wasp enlarged. (After Riley)

House or rain barrel mosquito[3]

This modest, brown, though by no means retiring mosquito, hardly needs an introduction. Its suggestive song is so well understood that we instinctively prepare for the inevitable. This mosquito takes advantage of man at every possible opportunity, while we tamely submit to a series of annoyances which could be eliminated at a less expenditure of energy than is necessary to endure repeated trials of patience with a reasonable degree of fortitude.

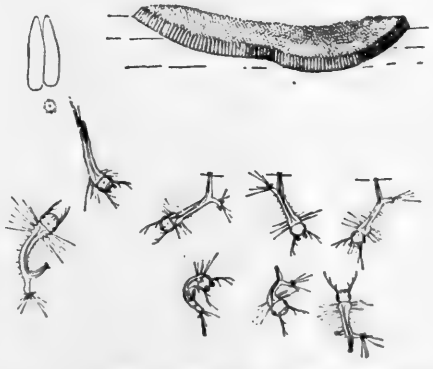

Fig. 8 House mosquito. Egg mass with enlarged eggs above and at the left; young wrigglers below. (Reduced from Howard, U. S. Dep't Agric. Div. Ent. Bul. 25. n. s. 1900)

Habits. This insect winters in small numbers in houses or other shelters, the females depositing clusters of eggs upon standing water on the approach of warm weather. Breeding may continue

[1] Vespa germanica Fabr.
[2] Polistes sp.
[3] Culex pipiens Linn.

under favorable conditions till checked by frosts in the fall. This domestic pest displays a marked partiality for water in rain barrels, cisterns, defective eave troughs, old wooden buckets, tin cans or similar receptacles. The black eggs are deposited in raftlike masses of some two to four hundred, and the entire development to the adult may occur within 14 days. One rain barrel may produce thousands of mosquitos and provide an abundance of these ubiquitous annoyances throughout a season.

Control. This species, like a number of other mosquitos, is quite local in habit and its presence may be construed as an indication of nearby breeding places. The elimination of useless barrels, tin cans, etc. will accomplish much toward reducing the numbers of this pest, and this should be supplemented by attention to gutters and eave troughs to see that they have not become bent or clogged so as to afford breeding places. Rain barrels and cisterns, if a necessity, may be rendered innocuous by covering them closely, even though nothing more substantial than mosquito netting be employed. Should this latter be undesirable, the surface may be kept covered with a film of kerosene, without detriment to the employment of the water for domestic purposes, provided the water be drawn from the lower part of the vessel.

Salt marsh mosquito[1]

The salt marshes, as might be presumed, present peculiar conditions and these are accompanied by a corresponding variation in animal life. Those at all familiar with marsh conditions have learned by experience about the large, voracious swarms of mosquitos which may occure in such sections.

Habits. The salt marsh mosquito is typical of several forms which breed by preference in brackish water. The short tubed, dark colored wrigglers are found here and there in pools, being by far the most numerous within two or three hundred feet of the high land, this area being that portion of the marshes flooded only by high tides. These more or less regular overflows of water result in numerous eggs hatching and the production of ravenous hosts of mosquitos, easily recognized by their white banded legs, beak and body, the latter in addition, bearing a conspicuous longitudinal white stripe. These insects differ greatly from our house mosquito, in that they fly considerable distances, there being authentic records of their having been found 40 miles from the

[1]Culex solicitans Walk.

nearest available breeding place. Occasionally hosts of these insects invade New York city to the great discomfort of the residents.

Control. The control of this species is practicable though at the outset it appears somewhat difficult. All that is necessary is to provide drainage so that pools of water will not stand more than a few days. This is accomplished by running narrow ditches within about 25 feet of the headland and 40 or 50 feet apart, all being connected with some tidal creek so that they are flushed out twice daily. The walls of the ditches should be perpendicular and the bottom at a uniform level. Experience has shown it inadvisable to have the walls sloping or to attempt to secure a uniform pitch, since the latter almost invariably results in pools not reached by the daily tides. This work has been conducted on an extensive scale in the vicinity of New York city with most gratifying results. Several types of ditching machines are in use and the work is comparatively inexpensive.

Fig. 9 Salt marsh mosquito from above, the toothed front claw more enlarged. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 25. n. s. 1900)

The elimination of mosquito breeding places on the salt marshes may sometimes be accomplished by the use of tidal gates and a series of drains. This method, while thoroughly effective, belongs to the domain of land development rather than to that of insect

subjugation. The additional cost in many cases may be more than met by the increased value of the marshes treated.

House fleas

The cat and dog flea[1] is the species most usually abundant in houses in New York State, judging from the specimens submitted with complaints. This species, as its common name indicates, occurs indiscriminately upon both the cat and the dog and may be found about their sleeping places. The minute, white eggs are laid mostly in such places. The slender, active larvae feed upon organic matter in cracks and crevices, and are most numerous

Fig. 10 Cat and dog flea, seen from the side, enlarged. (Original)

about the sleeping places of domestic animals. The flea is a prolific insect. The closing of a dwelling for several weeks or more in warm weather affords almost ideal conditions for rapid multiplication, and more than once householders have been surprised on returning to find the home overrun by these active, annoying pests. A rat flea is an important factor in the spread of bubonic plague.

Control measures. Fleas are very likely to occur on cats and dogs and if these animals must be retained in the home, care should be exercised to keep their sleeping places clean. Provide

[1] Ctenocephalus canis Curtis.

the animal with a mat or blanket upon which it may sleep. This mat should be taken up frequently, shaken and the collected dust beneath burned. This is a most effective method of preventing the multiplication of these insects. An animal known to be infested with fleas should have a quantity of fresh pyrethrum powder rubbed into the hair. This will stupefy the pests, causing them to drop off and then they may be swept up and burned. Dusting hosiery with pyrethum powder has been found very effective in preventing flea bites in situations where such precautions are advisable.

It is frequently very difficult to deal with a bad infestation, due to the impossibility of getting at the breeding places or destroying all of the fleas at one time. Dr Henry Skinner of Philadelphia states that he has successfully destroyed fleas in a badly infested room, by sprinkling the floor liberally with about 5 pounds of flake naphthalene and closing the room for 24 hours. The acrid fumes destroyed the fleas and inflicted no material injury. There is no danger in this procedure and we earnestly commend it to those troubled by this pest. Fumigation with hydrocyanic acid gas, described on page 48, where practical, is a most satisfactory method of dealing with this condition.

Bedbug hunter

This species[1] occasionally occurs about houses and with one or more allies was widely noticed by newspapers in 1898 under the name of kissing bug. This brownish or black insect is about ¾ of an inch long and has somewhat the same shape as the malodorous squash bug of the garden. It is beneficial, since it preys upon insects. The grayish, sprawly legged young are unusually interesting on account of their being covered with particles of lint. This gives them a nondescript appearance and undoubtedly is of service in enabling them to creep up unobserved upon their prey.

Fig. 11 Masked bedbug hunter or kissing bug, from above, about twice natural size. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 22, n. s. 1900)

[1] Opsicoetus personatus Linn.

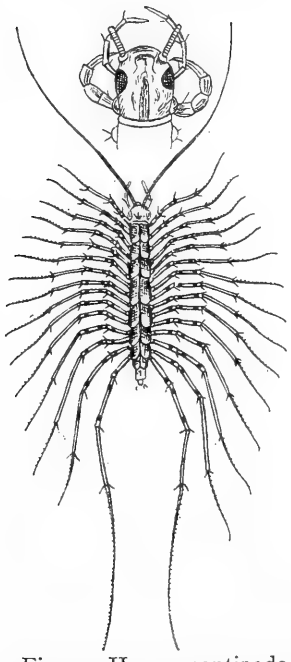

Fig. 12 House centipede; seen from above, enlarged, the head still more enlarged. (After Wood)

House centipede[1]

This light brown, rapidly running, sprawly legged centipede arouses more or less aversion and terror through apprehension. Like other centipedes, it is capable of inflicting a somewhat poisonous bite though, as a rule, it is only too glad to escape. The house centipede has become well established in the dwellings of Albany, N. Y., and is presumably more or less abundant in other cities of the State. It is beneficial in that it is known to prey upon house flies, cockroaches and other insects. Its presence in a house should be welcomed, since it is capable of inflicting no injury aside from a somewhat poisonous bite, the latter being extremely rare.

FABRIC PESTS

Clothes moths

The small, white caterpillars of these insects, frequently in a cylindric, webbed case, are very different from the young of the

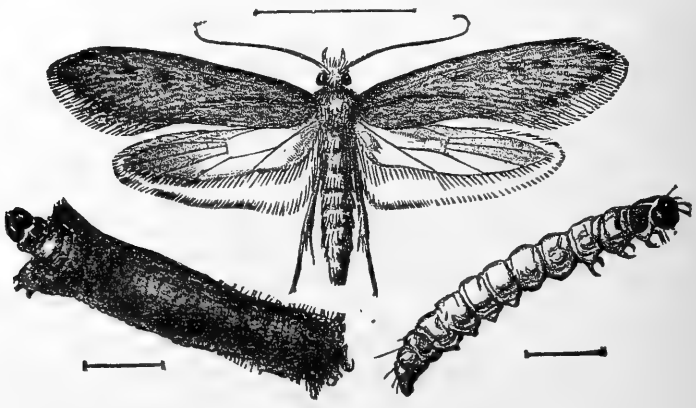

Fig. 13 The common case-making clothes moth; adult; larva and larva in case; enlarged. (After Riley)

carpet beetles noticed on page 30, one of which is frequently referred to as the Buffalo clothes moth. The true clothes moths

[1]Scutigera forceps Raf.

are small, grayish yellow moths or millers, indistinctly dark spotted and having a wing spread of less than half an inch. The progeny of not all small moths are injurious to fabrics, though several such destructive species occur in this State.

Description and habits. The most common form in New York State is known as the case-making clothes moth[1] easily recognized in the immature stage by the cylindric case which the small caterpillar drags around as it moves from place to place.

The webbing or southern clothes moth[2] is stated to be the more abundant and injurious species in the latitude of Washington though it occurs farther north. This species is about the same size as the preceding and has uniformly pale yellowish wings. The young or caterpillar does not construct a case but lines its runways with fine silk. This destructive caterpillar feeds on a variety of animal materials, having been found in woolens, hair, feathers and furs, and is frequently a troublesome pest in museums.

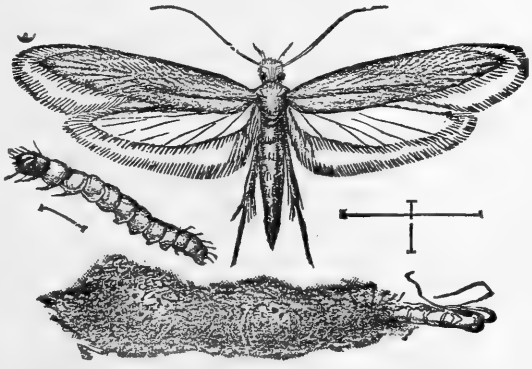

Fig. 14 Webbing or southern clothes moths: adult, larva, cocoon and empty pupal skin; enlarged. (After Riley)

The tapestry moth[3] is rare in this country and is larger than either of the other two, having a wing spread of about ¾ of an inch. The base of the forewings is black, the outer portion being a variable creamy white. This larger species displays a marked preference for the heavier fabrics, such as carpets and horseblankets and may be found in felting, furs, skins, carriage upholstering, etc.

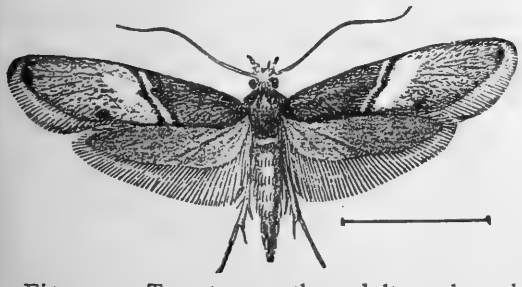

Fig. 15 Tapestry moth: adult, enlarged. (After Riley)

Control measures. Clothes moths, like carpet beetles, fleas and some other household pests, thrive best in situations where there is relatively little disturbance. Clothing used almost daily and other fabrics subject to frequent handling, brushing or sweeping

[1] Tinea pellionella Linn.
[2] Tineola biselliella Hum.
[3] Trichophaga tapetzella Linn.

are relatively immune from injury. Woolens and furs are most likely to be damaged while in storage during warm weather. These, before being laid away, should be thoroughly aired, brushed and carefully examined for the presence of the destructive larvae. Then they should be packed in cedar chests or tight boxes, preferably with some naphthalene or camphor, as these latter materials are of some service as repellents. A very effective and cheap method of storing articles for the summer is to put them in tight pasteboard boxes and seal the covers firmly with strips of gummed paper.

Valuable furs and similar articles are frequently deposited with storage companies. Experiments conducted under the direction of Dr Howard, Chief of the Bureau of Entomology, have shown that all danger of injury by clothes moths and their associates may be obviated by keeping the temperature at about 40° Fahrenheit. This is sufficiently low so that insects, even if present, will remain in a dormant and therefore harmless condition.

Occasionally a clothespress becomes badly infested by clothes moths. All garments should then be removed, aired, thoroughly brushed and care taken to destroy any larvae which may not have been dislodged by this treatment. The clothespress itself should be thoroughly brushed and cleaned. These measures should afford relief. It is a very poor plan to have in the attic or some unused part of the house miscellaneous woolens or other materials in which the pests can breed unrestricted, as such places are likely to serve as centers for the infestation of more valuable articles. Methods of fumigating are briefly discussed on pages 22, 48–50.

Spraying with benzine or naphtha two or three times during warm weather is advisable for the purpose of preventing injury to cloth-covered furniture, cloth-lined carriages and similar articles in storage or unused for extended periods. Care should be exercised to prevent the inflammable vapor of these oils gaining access to fire of any kind.

Carpet beetles

Housekeepers of Albany, N. Y., at least, are seriously troubled by carpet beetles. These destructive insects, it will be seen by referring to page 28, are very different from the clothes moths though operating somewhat in the same manner.

Description. The Buffalo carpet beetle[1] is a stout, oval beetle ⅛ of an inch long or less and easily recognized by its black and

[1] Anthrenus scrophulariae Linn.

white or yellowish white and red mottled wing covers. The red markings form an irregular line, with three lateral projections on each side, down the middle of the back. The common name Buffalo carpet beetle is suggestive of the shaggy, stout grub or larva, some ⅛ of an inch long, found working in carpets, more generally along seams or cracks in the floor.

The black carpet beetle[1] is a more slender, black or brownish beetle somewhat larger than the oval Buffalo carpet beetle, though rarely attaining a length of 3/16 of an inch. It is peculiar on account of the greatly produced terminal antennal segment in the male. The slender, reddish brown grub some quarter of an inch or more in length, is easily distinguished from that of the Buffalo carpet beetle by the long, brushy tail of reddish hairs and the sparse clothing of the tapering body.

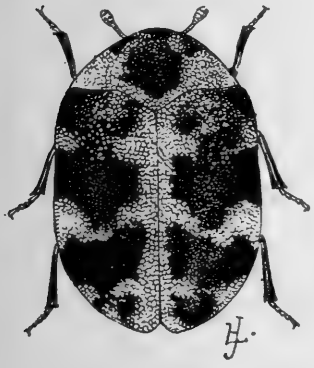

Fig. 16 Buffalo carpet beetle, seen from above, enlarged. (Original)

Habits. Both of these carpet beetles are rather common on flowers the latter part of May and early in June and may be brought into houses therewith. They also occur on windows in early spring, are found in the fall and occasionally in the winter. Both play possum when disturbed. The eggs of the Buffalo carpet beetle are deposited in convenient places and the young grubs develop quite rapidly. It is probable that there are not more than two generations in the North though the insects are active in warm houses throughout the year. The black carpet beetle has very similar habits though the development of its grub appears to be much slower. This latter insect is known to feed upon feathers and has been reared in flour and meal. Woolens are more liable to injury than other fabrics.

Control measures. Obviously it is advisable to destroy the beetles found about houses before they have had an opportunity of laying eggs. It is desirable to avoid bringing the pests into the house with flowers. Both of these insects breed in organic matter, presumably in outbuildings or outdoors, as well as within, fly to the flowers and may then, in the case of the Buffalo carpet beetle at least, be carried into dwellings before eggs[2] are deposited. The

[1] Attagenus piceus Oliv.

[2] Professor Slingerland, Rural New Yorker, 1896, 55:582, records obtaining eggs from Buffalo carpet beetles taken on flowers.

substitution of rugs or matting for carpets is advised in localities where the pests are destructive.

Infested carpets should be taken up and thoroughly cleaned, and if badly infested, sprayed with benzine. This latter should invariably be done outdoors, owing to the extreme inflammability of this oil. Local injury can frequently be stopped by passing a hot iron over a damp cloth laid on the affected part of the carpet. The steam penetrates the fabric and destroys the pest in its retreat. The danger of subsequent injury can be largely avoided by filling all cracks and crevices in poorly constructed floors with putty, plaster of paris or a crack filler. Laying tarred paper under a carpet has been frequently advised as a preventive.

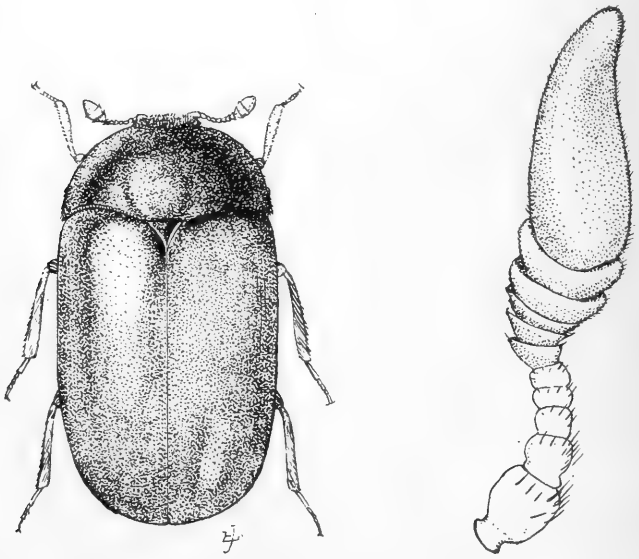

Fig. 17 Black carpet beetle, seen from above, enlarged; antenna of the male, still more enlarged. (Original)

These insects can undoubtedly be destroyed by fumigation with burning sulfur, bisulfid of carbon or hydrocyanic acid gas. The first named is frequently employed and though the fumes are very pungent, liable to blacken silver and cause other damage, particularly if considerable moisture is present, it is one of the safest fumigants. Bisulfid of carbon, on account of its inflammability, is hardly a safe material to employ in dwellings. Hydrocyanic acid gas has been used extensively in the last decade for the destruction of household pests. Directions for using it are given on page 48.

For the treatment of garments and furs stored during warm weather, see the discussion on page 30.

Silver fish, bristle tail or fish moth[1]

This peculiar, elusive insect is frequently the subject of inquiry by careful housekeepers. It is rather common about houses though rarely seen. It is about 3/8 of an inch long, silvery gray and tapering. Perfect specimens have very long antennae and three equally long appendages at the posterior extremity.

Habits. This insect feeds upon nitrogenous or farinaceous matter such as the sizing of paper, starch, paste etc. It has even been known to eat off the face of museum labels to such an extent as to render them illegible. It thrives best in places where there is comparatively little disturbance and is therefore rarely numerous in houses having few crevices and no storeroom where articles are allowed to remain undisturbed for months or even years at a time.

Control measures. This insect, if abundant, can be controlled to best advantage, according to Mr Marlatt, by slipping into their haunts pieces of paper liberally treated with a thick, boiled, starchy, preferably nitrogenous, paste poisoned with arsenic. This material should be used with extreme care and placed only where there is no danger of children getting hold of the poison. Ordinarily the dusting of this insect's haunts with fresh pyrethrum powder, followed by thorough cleaning, is preferable to the employment of an arsenical poison. Damage is most likely to occur in comparatively moist places or where articles are allowed to remain undisturbed for a year or more.

Book louse

This is a pale louselike insect[2] only 1/25 of an inch long and frequently designated as the "death watch" because of the peculiar ticking sound it makes. This latter is supposed to predict an early death in the family. An allied species[3] has similar habits and is considered to be the true "death watch." Both of these species, as well as allied forms, live upon vegetable matter and occasionally may become very abundant. There have been several records of this insect issuing in enormous numbers from mattresses stuffed with hair, corn husks or straw. An infestation of this kind can be controlled best by removing and burning the infested mattress. The apartment then should be thoroughly cleaned.

[1] Lepisma domestica Pack.
[2] Atropos divinatoria Fabr.
[3] Clothilla pulsatoria Linn.

White ants[1]

These insects, despite their general resemblance to the more common ants, are very different creatures. The flying ants, though having somewhat the same size as some of our winged, black ants, may be recognized at once by the numerous veins of the wings. White ants are frequently very injurious to buildings or their contents, particularly in Washington and to the southward. Occasionally they cause serious injuries in New York, and in at least one instance established themselves in safe deposit vaults and proceeded to destroy valuable records and to tunnel the wooden blocks of electrotypes. The whitish, wingless, antlike forms make large tunnels in woody and other vegetable fibers,

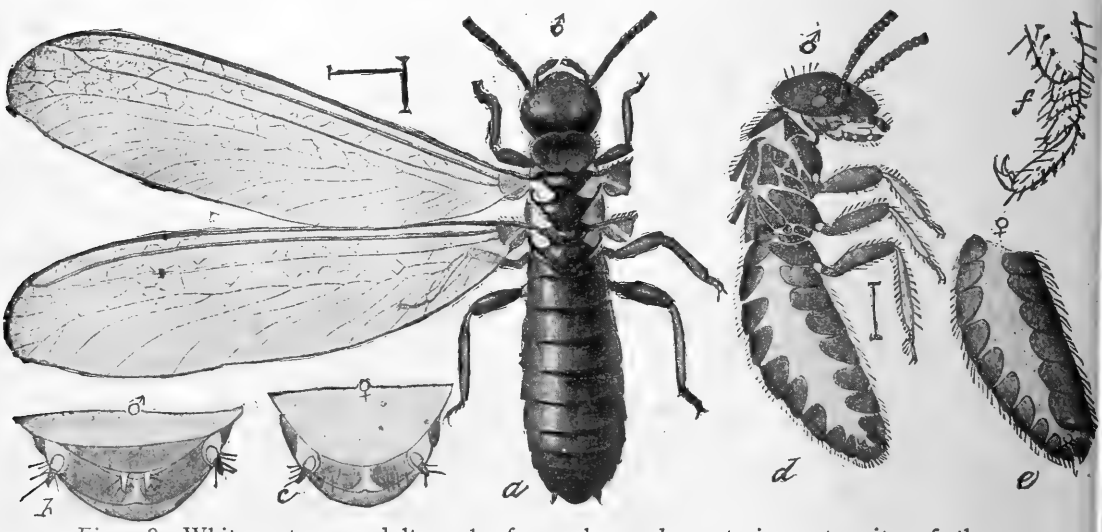

Fig. 18 White ants: *a*, adult male from above; *b*, posterior extremity of the same from below; *c*, the same of the female; *d*, male seen from the side; *e*, side view of the abdomen of the female; *f*, tarsus showing the segments and the claw; *a*, *d*, *e*, are enlarged; *b*, *c*, *f*, greatly enlarged. (After Marlatt, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

invariably avoiding the light. They pass from one object to another only through covered galleries. The secrecy with which these pests operate enables them to cause extensive injury before their presence is suspected. These peculiar insects are familiar to many who have observed their operations in an old stump.

Control measures. Nothing but the most thorough work will clean a building or a vault of these insects, because their burrowing habits enable them to get beyond the reach of destructive gases. An infested vault should have everything removed, every crack and crevice thoroughly cleaned and then special attention given to doors or other means of entrance, to see that there is no possi-

[1] Termes flavipes Kollar.

bility of insects entering through an unsuspected crevice. Before replacing the contents of the vault, wood, papers or other materials likely to be infested should be most carefully examined and, if necessary, thoroughly heated or repeatedly fumigated with some gas. Great care should be exercised to prevent the reinfestation of any such place. It is even more difficult to control this pest in buildings, since if it becomes abundant nothing can be done aside from installing brick, stone or concrete foundations. This form of construction is especially advisable in warmer sections of the country. Where books, papers and exposed woodwork only are infested, thorough and protracted fumigation with hydrocyanic acid gas, described on page 48, may be advisable.

Crickets

These black, chirping, nocturnal insects[1] occasionally make their way into houses and for the most part are welcome. Sometimes they may cause serious injury. Dr Lintner records a case where a suit of clothes, just from the tailor, was completely ruined in a night by the common black field cricket[2] which had entered an open window in some numbers. Such injury is exceptional. Crickets can be destroyed where necessary by the use of ground-up carrots or potatoes to which a liberal amount of arsenic has been added. They may also be caught by taking advantage of their liking for liquids and placing low vessels containing beer or other fluids about their haunts.

FOOD PESTS

House ants

There are several species of ants likely to occur in houses. These little insects are not specially destructive nor obnoxious aside from their faculty of getting into everything.

The little red ant[3] is particularly troublesome, since its small size, it being only about 1/16 of an inch long, enables it to enter almost any receptacle not hermetically sealed. Furthermore, this little pest is very prolific and occasionally literally overruns buildings to the serious discomfort of the inhabitants. This tiny species is perhaps the most common and the most abhorred of all, owing to the difficulty of eradicating it.

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[1] Gryllus domesticus Linn. and others.
[2] Gryllus luctuosus Serv.
[3] Monomorium pharaonis Linn.

The little black ant[1] is about ¼ of an inch long and though normally occurring under stones in yards, also invades the house in considerable numbers.

The pavement ant[2] is about ⅜ of an inch long and is very common along the Atlantic seaboard.

The large, black ant[3] is the giant among our household ants. It may be half an inch or more in length, is normally a wood feeder and has frequently been designated as the carpenter ant. This large species occasionally invades buildings, particularly in the country, lives in the timbers and makes systematic levys upon the food supplies of both kitchen and pantry. Occasionally this species may become very abundant in a dwelling.

Control measures. A house badly infested by ants, particularly if a rather old building, might well be thoroughly fumigated with

Fig. 19 Red ant: *a*, female; *b*, worker or neuter, enlarged. (After Riley)

hydrocyanic acid gas, directions for which are given on page 48. This method of treatment is especially good for the little red ant, because its nests are usually in the walls of the building and therefore inaccessible.

Aside from the fumigation mentioned above, the next most satisfactory method of controlling these pests is to search for their nests and destroy them so far as possible. This can be accomplished only by ascertaining the origin of the continuous stream of ants and is frequently impossible. The little black ant and the pavement ant are very likely to build nests outdoors under stones. Should the nests be found they can be destroyed by liberal applications of boiling water or spraying with kerosene. Outdoor nests

[1] Monomorium minutum Mayr.
[2] Tetramorium caespitum Linn.
[3] Camponotus herculeanus Linn.

of ants can be destroyed by the use of carbon bisulfid. Make a hole several inches deep with a broom handle and put therein about 1 ounce of carbon bisulfid and cover quickly. In the case of a large nest, several holes should be made at a distance of a foot or a foot and a half and each charged with carbon bisulfid. A more recent method is scooping out a portion of the soil and filling the cavity with a solution of cyanide of potassium, using 1 ounce of this deadly poison to a gallon of water. Another probably equally effective method is the sprinkling of the surface of the nest with fine particles of potassium cyanide. This material, it should be remembered, is a most dangerous poison and every precaution should be taken to avoid disastrous results. The nests of the large black ant are usually found in timbers, such as studding in the walls and are therefore wellnigh inaccessible. The writer has seen 2 x 4 joists badly riddled by the operations of this insect.

Trapping the ants by means of sponges dipped in sweetened water is frequently advised and gives good results if conscientiously carried out. First, attractive foods should be removed, so far as possible, prior to the distribution of the pieces of sponge saturated with sweetened water. These latter should be gathered from time to time and the ants clinging thereto destroyed by dropping in boiling water.

Cockroaches

Cockroaches and their smaller cousins, the croton bugs, are frequently the bane of the neat housekeeper, particularly in old city dwellings. These species are distributed through commercial agencies and have become well established in most large cities and villages on the principal routes of travel, especially seaports and places on rivers or canals, since these pests are invariably found on ships and boats. The old houses with their numerous inaccessible crannies and crevices afford a multitude of hiding places and enable the roaches to exist year after year, in spite of strenuous efforts to exterminate them.

Description. At least three species of cockroaches may be found in houses. The American cockroach[1] is a large, dark brown species nearly an inch and a half long and has well developed wings. The Oriental cockroach or black beetle[2] is a nearly wingless, dark brown or black form about an inch long. The Australian

[1] Periplaneta americana Linn.
[2] Periplaneta orientalis Fabr.

cockroach,[1] frequently brought to our shores by vessels, is a reddish brown form about an inch and a quarter long, easily recognized by the yellow, irregular, oval markings just behind the head. A slender, light green cockroach[2] about an inch long is occasionally introduced with tropical fruits. The smallest and the most pestiferous of all is the croton bug,[3] a light brown, dark marked cockroach only about ¾ of an inch in length.

Habits. The larger American or European cockroaches are frequently somewhat abundant, but the most numerous is the smaller croton bug. These insects find the dampness of water pipes very congenial, and on account of their abundance in such places, they are widely known as water bugs. Roaches, both large and

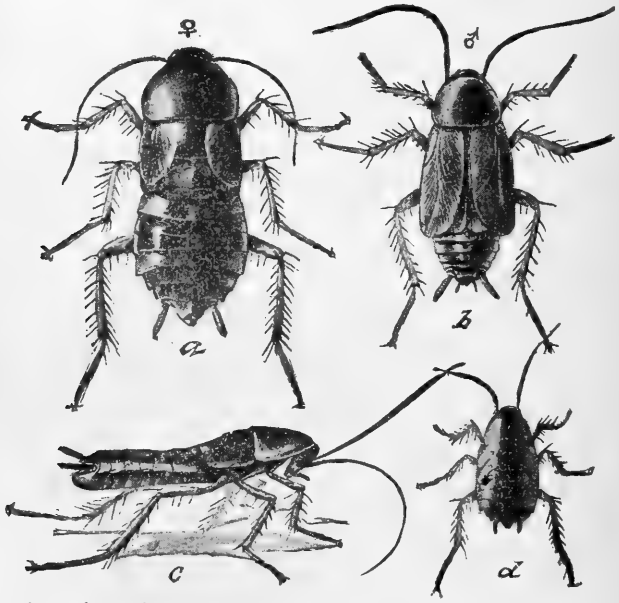

Fig. 20 Oriental cockroach: *a* and *c*, female from above and the side; *b*, male; *d*, a half grown individual; all natural size. (After Marlatt, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

small, feed upon a variety of vegetable and animal matter. The refuse scraps of the sink, the food on the pantry shelves, woolens, leather of shoes, furniture or books, the sizing or paste of cloth-bound books and similar materials are all liable to be gnawed by these almost omnivorous pests. Aside from the actual amount of injury inflicted, the fetid, roachy odor is imparted to infested food stuffs. It is only fair to state that these disgusting pests are known to feed upon that horror of the housewife, the bedbug. There is small choice between the two evils.

[1] Periplaneta australasiae Linn.
[2] Panchlora hyalina Stahl.
[3] Ectobia germanica Linn.

Control measures. Badly infested houses can be cleared of these pests most easily by thorough and perhaps repeated fumigations with hydrocyanic acid gas as described on page 48. Carbon bisulfid, has also been advised as a fumigant. On account of the inflammability of the latter, we would prefer to use in houses the somewhat more poisonous hydrocyanic acid gas. Carbon bisulfid with its heavy fumes is particularly adapted to the destruction of these pests in the holds of vessels.

A still safer method of fumigation consists in burning pyrethrum in infested compartments. It is stated that the vapors of this insecticide are frequently more effective in destroying roaches than the use of the powder itself. The room should be kept closed from six to ten hours. The smoke of burning gunpowder is also very obnoxious and deadly to roaches, particularly the black Eng-

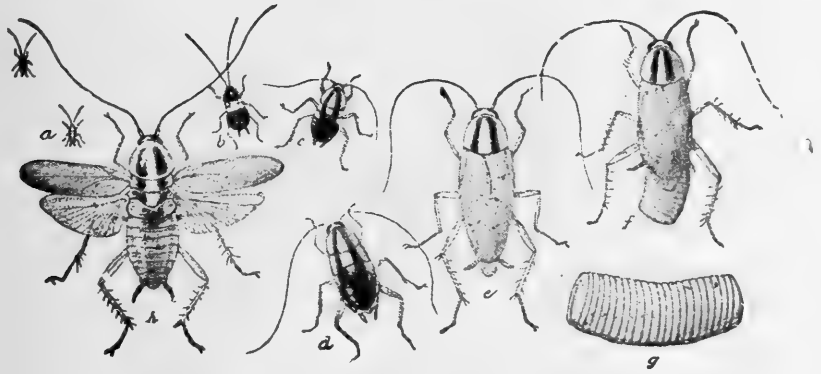

Fig. 21 Croton bug: *a, b, c, d,* successive stages in the development of the young; *e,* adult; *f,* female, with egg case; *g,* egg case enlarged; *h,* adult, with wings spread; all natural size except *g.* (After Riley)

lish roach. The moistened powder should be molded into cones, placed in an empty fireplace and ignited. It is especially valuable in the case of old houses.

There are a number of roach poisons placed upon the market and some of these are undoubtedly very efficacious, particularly if assisted by persistent cleanliness and the eradication of inaccessible haunts, so far as possible. We would further suggest the testing of naphthalene in the flake form, as described on page 27, as a means of at least partially suppressing this pest. The liberal use of Persian insect powder or pyrethrum is also of service in destroying these insects. The paralyzed cockroaches should be swept up and burned.

A relatively simple method, described by Mr Tepper of Australia, is to mix plaster of paris one part, and flour three or four

parts, in a saucer and place the preparation about the haunts of the pests. Near by there should be a saucer containing a little water and made easily accessible to the roaches, by laying a few sticks as bridges up to the rim. The insects eat the mixture, drink the water and soon succumb.

There are several methods of trapping cockroaches, particularly the larger species. A deep vessel partially filled with stale beer or ale can be placed in roach haunts and small sticks adjusted so that the insects can crawl over the edge and to within a short distance from the surface of the liquid. The pests fall into the trap and, being unable to escape, are drowned in large numbers. This method is of comparatively little service with the smaller, more wary croton bug.

Larder beetle[1]

The parent insect, a stout, dark brown beetle with the base of the wing covers mostly yellowish, is frequently rather common about houses in May and June. This insect breeds by preference on animal matter such as ham, bacon, various meats, old cheese, horns, hoofs etc. The very hairy, brown grub is about ½ inch long when full grown.

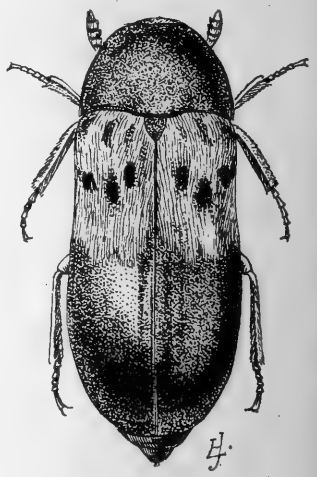

Fig. 22 Larder beetle, seen from above, enlarged. (Original)

Meats and other food stuffs attractive to this insect should be stored in places inaccessible to the beetles. It is said that old cheese can be used very successfully for trapping the parent insects. Cheese or meat infested by the grubs should have the affected part cut away and the surface washed with a very dilute carbolic solution. The packing of meats in tight bagging is of considerable service in preventing attack.

Cheese skipper

The cheese skipper[2] is the young of a small, black, glistening fly about 3/16 of an inch long. The white, cylindric maggots are easily recognized by their peculiar jumping power. This is accomplished by bringing the two ends of the body together and then suddenly

[1] Dermestes lardarius Linn.
[2] Piophila casei Linn.

straightening with a quick muscular action. The maggots of this insect are likely to occur on cheese, particularly that which has been kept for some time, and also upon ham. This species has proved to be a serious pest in some packing houses. It is more or less abundant about cheese factories.

This little pest can be best controlled by storing products likely to be injured, in a dark place. Scrupulous cleanliness is a most efficient preventive. Rubbing daily the bandages and sides of cheese, in hot weather, has been recommended for the purpose of destroying or brushing off eggs. The cheese may be washed with hot whey or with lye, the latter acting as a repellent. Smoked

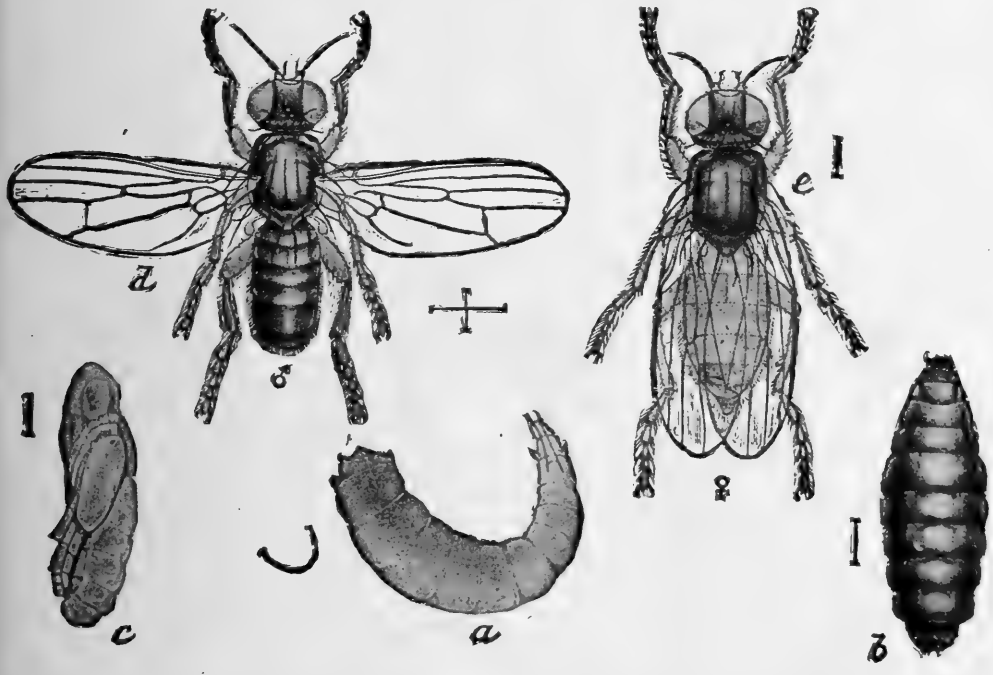

Fig. 23 Cheese skipper: *a*, maggot or larva; *b*, puparium; *c*, pupa; *d*, male fly; *e*, female; all enlarged. (After Howard, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

meats should be put in places inaccessible to the flies. A fine screen, 24 to the inch wire mesh, effectively excludes this little insect.

Cheese or meat infested by skippers is not necessarily ruined, since the injured parts can be cut out and the remainder used as food.

Cereal and seed pests

A number of these insects are likely to occur in houses and, on account of their somewhat similar habits, they are discussed under

a general head. Most of these species are important because of their infesting cereals or cereal preparations of one kind or another.

The Indian meal moth[1] has a wing spread of ¾ of an inch and is easily recognized by the outer two thirds of the wings being reddish brown and with a coppery luster. It is one of the more common of our cereal pests. The whitish, brown-headed caterpillar lives in a large variety of substances, including all cereal preparations and such diverse materials as various nuts, dried fruits, seeds etc. The caterpillar spins a light web to which particles of its food and frass adhere, thus injuring much that is not consumed and affording a ready means of detecting the presence of the pest.

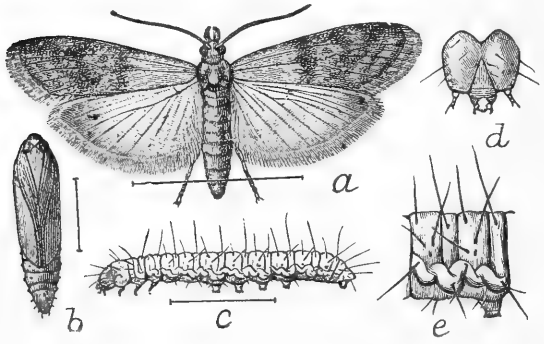

Fig. 24 Indian meal moth: *a*, moth; *b*, pupa; *c*, caterpillar from the side; *d*, head and *e*, first abdominal segment of caterpillar, more enlarged. (After Chittenden, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

The meal snout moth[2] with its different shades of brown and reddish reflections has a wing spread of about ¾ of an inch. The whitish caterpillar has a brown head and lives in long silken tubes. It subsists mostly upon cereals though it has been recorded as feeding upon other seeds and dried plants and displaying a preference for clover.

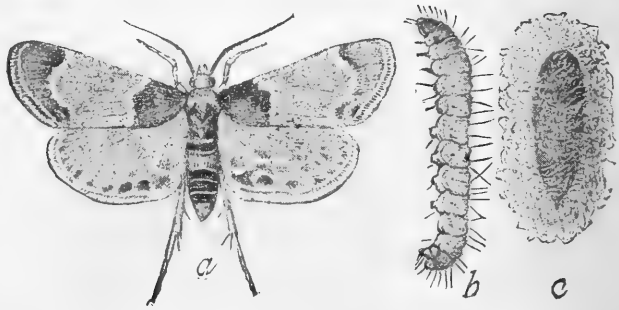

Fig. 25 Meal snout moth: *a*, adult; *b*, larva; *c*, pupa in its cocoon; twice natural size. (After Chittenden, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

[1] Plodia interpunctella Hubn.
[2] Pyralis farinalis Linn.

The saw-toothed grain beetle[1] is one of the smallest and most persistent of the grain beetles. It is only about 1/10 of an inch long, reddish brown, flattened and easily recognized by the peculiar saw edge along the sides of the thorax. It displays a marked preference for all cereal preparations though it occurs in pre-

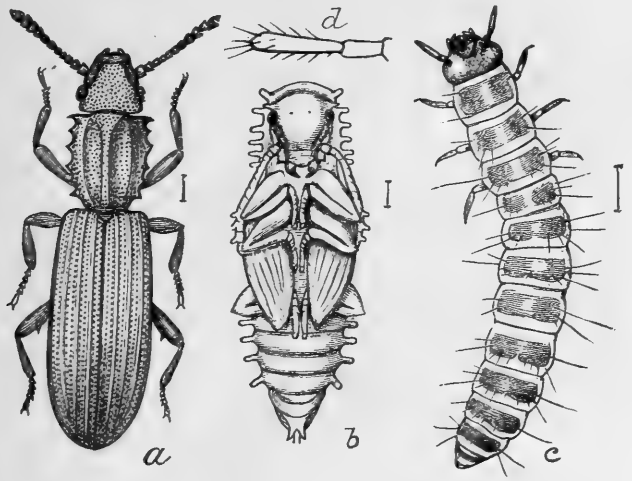

Fig. 26 Saw-toothed grain beetle: *a*, beetle, from above; *b*, pupa, from below; *c*, grub or larva; all enlarged. (After Chittenden, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

served fruits, nuts and seeds and has been recorded as injuring yeast cakes, mace, snuff and even red pepper. This species will breed for extended periods in packages of cereals. The writer had his attention called recently to a case where this beetle multiplied

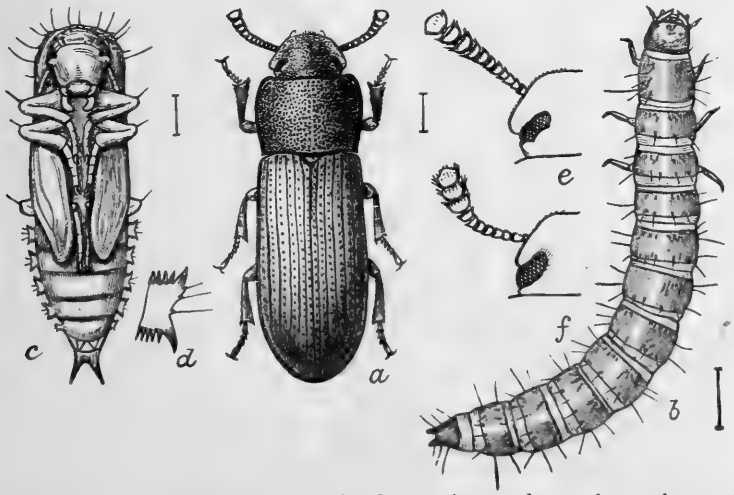

Fig. 27 Confused flour beetle: *a*, beetle from above; *b*, grub or larva, from above; *c*, pupa, from below; all enlarged; *d*, *e*, and *f*, structural details. (After Chittenden, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

by the millions in a brewery, spread therefrom to adjacent houses and caused a great deal of annoyance by getting into everything, not excepting clothing that was worn and bedding in use.

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[1] Silvanus surinamensis Linn.

The confused flour beetle[1] is a stout, rust-red beetle about 1/6 of an inch long. It, like the preceding form, has a marked liking for cereal preparations, though it occurs in such diverse products as ginger, cayenne pepper, baking powder, orris root, snuff, slippery elm, peanuts and various seeds. A closely allied form with similar habits, known as the rust-red flour beetle[2] occurs mostly in the Southern States.

The meal worms are rather common pests of meal and the ordinary stable foods. The large, brown or dark brown parent beetles have a length of about 5/8 of an inch and are frequently

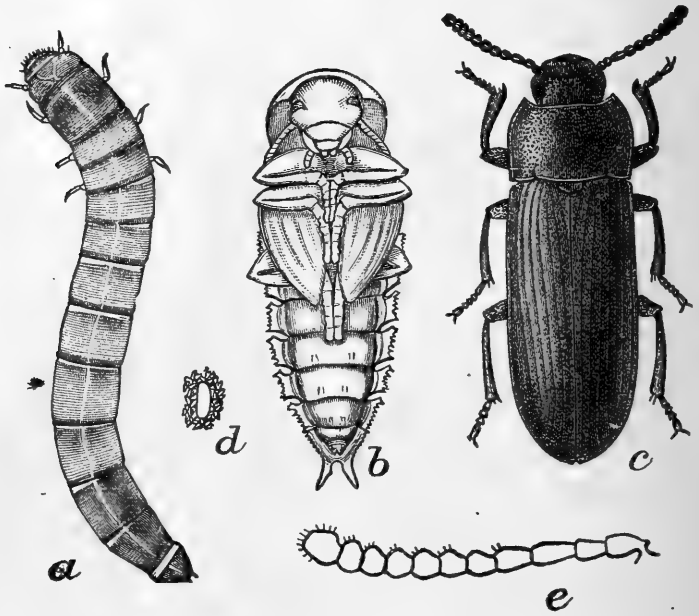

Fig. 28 Meal worm: *a*, larva; *b*, pupa; *c*, female beetle; *d*, egg, with surrounding case; *e*, antenna. *a*, *b*, *c*, *d*, about twice natural size, *e*, more enlarged. (After Chittenden, U. S. Dep't Agric. Div. Ent. Bul. 4. n. s. 1896)

found about houses. There are two closely allied species; the yellow meal worm[3] and the dark meal worm[4]. Both occur under similar conditions and have nearly the same habits. The beetles are frequently attracted to lights. The young or grubs are an inch or more in length, cylindric and yellowish brown. In addition to meal and similar products, they have been found in adulterated black pepper, commercial soda ash, phosphate fertilizers, in the latter instances undoubtedly feeding upon organic matter, possibly cotton seed meal, a well known food of these beetles.

[1] Tribolium confusum Duv.
[2] Tribolium ferrugineum Fabr.
[3] T. molitor Linn.
[4] Tenebrio obscurus Linn.

The cadelle[1] is another inhabitant of grain bins. The beetle is rather stout, shining, dark brown and about 3/8 of an inch long. The peculiar grub or larva, over an inch long, is easily recognized by its flattened appearance and the dark brown plates just behind the head and at the opposite extremity of the body. This species,

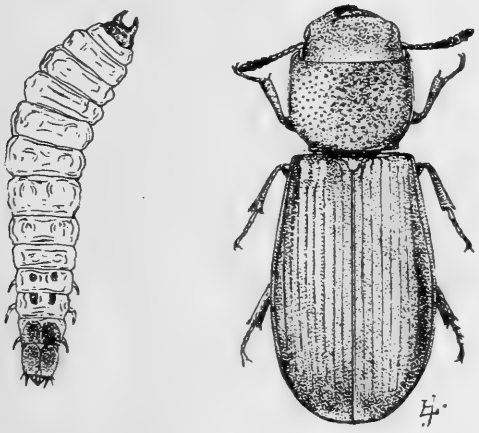

Fig. 29 Cadelle, beetle and larva, from above, enlarged. (Original)

according to Chittenden is predaceous as well as herbivorous. The grub has a faculty for turning up in unexpected places, as for example in milk which had evidently been adulterated with some farinaceous material. It has been found in white hellebore and even in granulated sugar.

The drug store beetle[2] is a rather stout, light brown beetle about 1/8 of an inch long, which attacks a large variety of substances. It occurs in mills, granaries and warehouses, living upon flour, meal, breakfast foods, condiments, roots and herbs and animal sub-

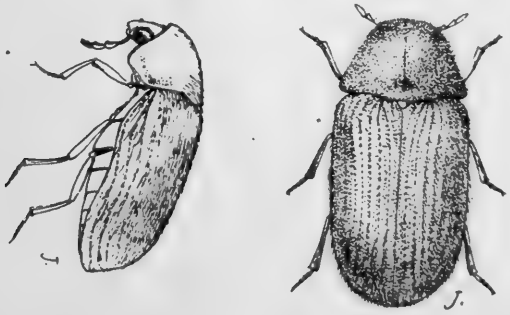

Fig. 30 Drug store beetle, seen from above and the side, enlarged. (Original)

stances. It has even been known to colonize itself in a human skeleton which had been dried with the ligaments left on, and has been recorded as perforating tinfoil and sheet lead. Only two

[1] Tenebrioides mauritanicus Linn.
[2] Sitodrepa panicea Linn.

months are required to complete the life cycle and in warm dwellings breeding may be continuous throughout the year.

The cigarette beetle[1] is another tiny omnivorous species. The beetle is light brown, stout, slightly hairy and only 1/8 of an inch long. It infests a large variety of food stuffs, including condiments such as cayenne pepper, ginger and rhubarb; drugs of various kinds as ergot and tumeric, and even dried herbarium specimens. It has also been recorded as destructive to silk and plush upholstery. It is best known on account of its work in tobacco,

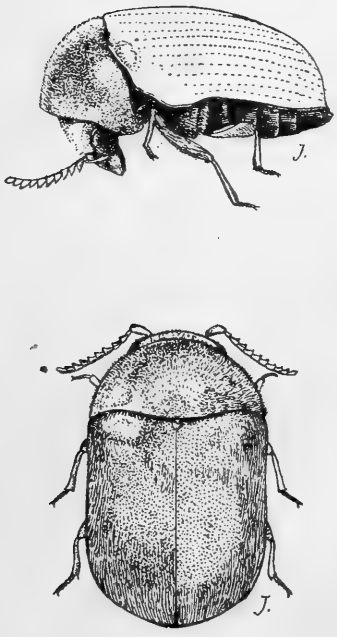

Fig. 31 Cigarette beetle, seen from above and the side, enlarged. (Original)

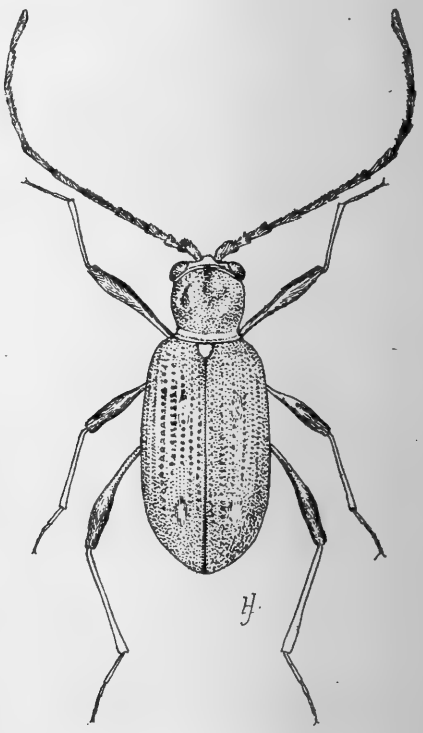

Fig. 32 Spider beetle, seen from above, enlarged. (Original)

cigarettes in packages being frequently perforated by this tiny pest. It occasionally becomes a very serious pest in tobacco warehouses and factories.

Spider beetles. The white marked spider beetle[2] is a small, reddish brown form with four white marks on its wing covers. Its long antennae and legs and subglobular body are suggestive of a spider, hence the common name. This species feeds upon a large variety of dried vegetable and animal substances, such as insect collections, dried plants and herbaria, red pepper, cotton seed,

[1] Lasioderma serricorne Fabr.
[2] Ptinus fur Linn.

refuse wool, and is said to be injurious to furs, clothing, roots, grain, stuffed animals, etc. The brown spider beetle[1] lives with the preceding, has similar habits and differs principally in the absence of the white markings.

The pea weevil[2] and various bean weevils[3] are stout, grayish weevils most easily recognized by their occurring respectively in peas and beans. The original infestation usually takes place in the field, though these insects are capable of breeding for extended periods in the dried seeds of their food plants. The presence of the beetles in a house is an almost infallible indication of infested peas or beans. It is usually more satisfactory to burn a small lot infested by these insects.

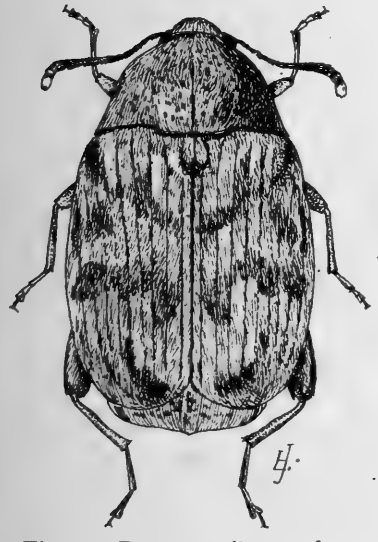

Fig. 33 Bean weevil, seen from above, enlarged. (Original)

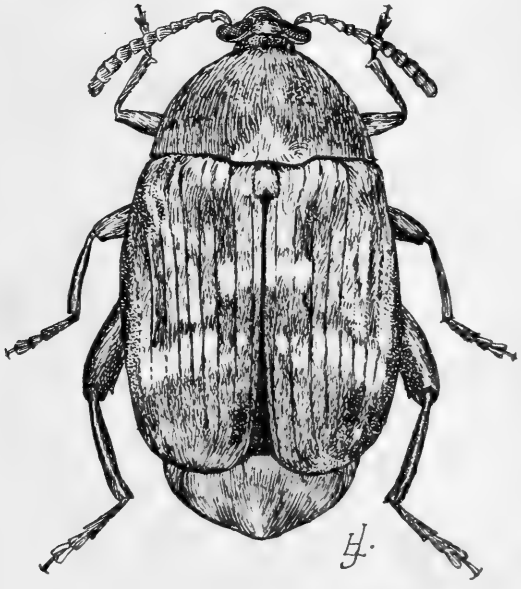

Fig. 34 Pea weevil, seen from above, enlarged. (Original)

Control measures. It is comparatively easy, with the exercise of a moderate degree of care, to avoid serious injury by any of these pests, since they invariably require access to a liberal amount of food for an extended period. Any materials likely to produce numbers of these insects should not be allowed to lie undisturbed and accessible for a series of months. Most of these pests can easily be destroyed by heating the infested material for a period of 4 or 5 hours to about 125 or 150 degrees Fahrenheit. This should be done carefully and time enough given so that the heat will penetrate and destroy all of the insects. Anything infested should be

[1] Ptinus brunneus Duft.
[2] Bruchus pisorum Linn.
[3] B. obtectus Say and others.

promptly cared for either by destroying the entire package or if heating is inadvisable by treating the same with carbon bisulfid.

Fumigation with carbon bisulfid is comparatively easy of execution since it is only necessary to put the material in a tight pail or can, put on the top a spoonful or thereabouts of the insecticide in a shallow saucer or plate, cover the receptacle tightly and allow the whole to stand for preferably 24 or 36 hours. This insecticide may be used on a large scale according to Dr W. E. Hinds, at the rate of 5 pounds to 1000 cubic feet of space, provided the compartments are exceptionally tight and the temperature above 70 degrees F.

FUMIGATION WITH HYDROCYANIC ACID GAS

This is one of the most effective methods of destroying insects in houses, particularly if the infestation is general. It should be remembered at the outset that potassium cyanide, sulfuric acid and their derivative, hydrocyanic acid gas, are among our most active and deadly poisons. They should be handled with extreme care and every precaution taken to avoid an accident, since a slight mistake might result in one or more fatalities.

One ounce of high grade, 98% cyanide of potassium and one fluid ounce of the best commercial sulfuric acid, diluted with two fluid ounces of water, should be used for every 100 cubic feet of space. These amounts should be doubled for poorly constructed houses. The fumigation should last at least 30 minutes and it would be preferable to have it continue three or four hours, or if feasible, all night.

Prior to treatment all fluids, especially liquid or moist foods, should be removed from the house. Arrangements should be made to open the building from the outside after the fumigation is completed. Windows and doors should be sealed as tightly as possible, either by stuffing damp paper in the crevices or pasting strips of paper over cracks. Chimney places, ventilators and other orifices should be closed tightly. The gas is generated by dropping the cyanide of potassium, previously broken into lumps about the size of a walnut and preferably placed in thin bags or wrapped loosely in thin paper, into the requisite amount of diluted acid. The acid should be carefully diluted by pouring it slowly, accompanied by frequent stirring, into the necessary amount of water. This dilution should be slow enough to avoid all danger of this very strong acid splashing and perhaps causing dangerous burns. It will be found

advisable to have one or more jars or generators in each room or hallway, since it is not wise to use more than two pounds of cyanide in a generator. The large, preferably deep, earthenware vessels used as generators should be placed near the middle of the room and on a thick layer of newspapers in order to avoid possible injury from splashing acid. Precautions should be observed, if the building is in contact with others in a row, to see that parties in adjacent dwellings are warned and arrangements made so that the rooms next the treated building will be kept well aired during the fumigation. It is unsafe to attempt to fumigate individual rooms in a house or a building in a row, unless one can be certain that there will be good aeration on all sides of the apartment or building. The deadly character of this gas is shown by the destruction of sparrows resting upon the eaves of a building during fumigation. One should not attempt to fumigate a building or a room alone, because an accident under such conditions is very likely to result fatally. Since hydrocyanic acid gas is lighter than air, operations should commence at the top of the building and proceed successively from floor to floor. Better still, place the requisite amount of the cyanide of potassium in thin bags, suspend each over its generator in such a manner that when a string near the exit is loosened, all will drop into the jars. The poison should not be in a thick paper bag, as the action of the acid may be seriously hindered if not almost prevented.

Under no conditions should any one be allowed to enter the building prior to the completion of the fumigation and its thorough aeration. At least 30 minutes and preferably an hour or more, depending somewhat upon the means of ventilation, should be allowed for this latter process. It is unsafe to enter any recently fumigated building until all the odor of the gas, resembling that of peach kernels, has disappeared. The contents of the fumigating jars should be carefully disposed of together with any remaining cyanide. These substances can either be buried deeply in the soil, or if in a city, may be poured into the sewer.

The following memoranda will doubtless prove of service in practical work.

1 Estimate the cubical contents and the amount of materials for each room.

2 Remove all liquids and moist foods in particular.

3 Seal all exits tightly with strips of paper or by filling crevices.

4 Provide for ventilation from the outside.

5 Weigh out the cyanide and place it in thin bags or do it up loosely in thin paper.

6 Place the generators in the various rooms, each upon a thick layer of newspapers.

7 Dilute the acid carefully and put it in the generators.

8 Distribute the amounts of cyanide to the various rooms.

9 Be certain that everything is all right and nobody in the building or room. *Notify* occupants of adjacent rooms or houses that the fumigation is to be commenced.

10 Drop in the cyanide, preferably from near the exit and close tightly.

11 Adopt suitable precautions to prevent the room or building being entered during the fumigation period.

12 Open the ventilators from the outside.

13 After the building has been thoroughly aerated, remove the generators and take care of their contents together with any excess of cyanide.

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New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

PUBLICATIONS

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Museum annual reports 1847–date. *All in print to* 1894, 50c *a volume*, 75c *in cloth;* 1894–*date, sold in sets only;* 75c *each for octavo volumes; price of quarto volumes on application.*

These reports are made up of the reports of the Director, Geologist, Paleontologist, Botanist and Entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904–date.

1904. 138p. 20c.
1905. 102p. 23pl. 30c.
1906. 186p. 41pl. 35c.
1907. 212p. 63pl. 50c.
1908. 234p. 39pl. map. 40c.

These reports cover the reports of the State Geologist and of the State Paleontologist. Bound also with the museum reports of which they form a part.

Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, 8vo; 2, 14–16, 4to.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899–1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837–41, are out of print.

Reports 1–4, 1881–84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	17	$.75	21	$.40
14	.75	18	.75	22	.40
15, 2v	2	19	.40	23	.45
16	1	20	.50	[*See* Director's annual reports]	

Paleontologist's annual reports 1899–date.

See first note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901–3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–20 bound also with museum reports 40–46, 48–58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3–4, 17 are out of print other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	10	$.35	18 (Bul. 64)	$.20
2	.30	11	.25	19 (" 76)	.15
5	.25	12	.25	20 (" 97)	.40
6	.15	13	*Free*	21 (" 104)	.25
7	.20	14 (Bul. 23)	.20	22 (" 110)	.25
8	.25	15 (" 31)	.15	23 (" 124)	.75
9	.25	16 (" 36)	.25	24 (" 134)	.35

Reports 2, 8–12 may also be obtained bound in cloth at 25c each in addition to the price given above.

Botanist's annual reports 1867–date.

Bound also with museum reports 21–date of which they form a part; the first Botanist's report appeared in the 21st museum report and is numbered 21. Reports 21–24, 26, 31–41 were not published separately.

Separate reports for 1871–74, 1876, 1888–98 are out of print. Report for 1899 may be had for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), 56th (1902), 57th (1903), 58th (1904), 59th (1905), 60th (1906), in volume 2 of the 61st (1907) and 62d (1908) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887–date. 8vo. *To advance subscribers, $2 a year or $1 a year for division (1) geology, economic geology, paleontology, mineralogy; 50c each for divisions (2) general zoology, archeology and miscellaneous, (3) botany, (4) entomology.*

Bulletins are grouped in the list on the following pages according to divisions.

The divisions to which bulletins belong are as follows:

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JOHN M. CLARKE, Director

Museum Bulletin 137

GEOLOGY OF THE AUBURN-GENOA QUADRANGLES

BY

D. D. LUTHER

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UNIVERSITY OF THE STATE OF NEW YORK

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Science Division, October 23, 1909

Hon. Andrew S. Draper LL.D.
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SIR: I have the honor to communicate herewith for publication as a bulletin of the State Museum, geological maps of the Auburn and Genoa topographical quadrangles, with the necessary explanatory matter pertaining thereto.

Very respectfully
JOHN M. CLARKE
Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 25th day of October 1909

Commissioner of Education

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Museum Bulletin 137

GEOLOGY OF THE AUBURN-GENOA QUADRANGLES

BY

D. D. LUTHER

INTRODUCTION

The area embraced within the Auburn-Genoa quadrangles lies between the lines of 42° 30′ and 43° north latitude and 76° 30′ and 76° 45′ west longitude and contains 455 square miles.

The waters of Cayuga lake cover 65 square miles of this area, Owasco lake 10 square miles and the alluvium along the Seneca river 6 square miles, while about 50 square miles in the towns of Montezuma, Aurelius, Throop and Sennett are a low lying region where no outcrops of bed rock occur but the surface is highly diversified by the large number of lenticular hills or drumlins into which the heavy drift sheet is arranged.

These drumlins, the more prominent of which are 100 to 150 feet in hight and usually many times longer than wide, rise quite abruptly at the north ends and extend in a generally south-southeast direction, gradually diminishing in size. The contour lines of the map indicate the position of more than 60 drumlins in characteristic shape and 100 feet or more in hight, while many others are equally well defined, though less prominent. The region in which these occur is a small portion of the New York drumlin area which covers 2500 square miles and is estimated to include 10,000 drumlin crests. The drumlins of central western New York have been described by Prof. H. L. Fairchild in State Museum Bulletin 111.

The south edge of the drumlin belt is along the foot of the Helderberg limestone escarpment which extends across the Auburn quad-

rangle from the northeast corner in a southwestern direction to Cayuga lake at Union Springs. Over most of this higher ground south of this limestone escarpment the drift sheet is quite thin, probably something less than 20 feet on the average, but it is gathered in many places into hills of a drumlin character, and, in a few instances in the vicinity of the foot of Owasco lake, into well defined drumlins. The remaining portion of the area included within the limits of these quadrangles is on the sloping sides of the Cayuga lake, Owasco lake and Salmon creek valleys where there are numerous ravines, some of which are large and afford fine rock exposures. The rocks are finely and accessibly displayed by nearly 50 miles of cliffs along the lake shores.

These favorable conditions for the study of the stratigraphy and paleontology of this section of central New York and the easy accessibility of the region, led to its early investigation and description by Vanuxem and Hall, while engaged on the Geological Survey of the third and fourth districts, and have made it classic ground to students of those sciences in later days.

The following geologic formations are represented by colors on the map of the Auburn-Genoa quadrangles in descending order:

- Devonic
  - Senecan
    - West Hill flags and shales
    - Grimes sandstones
    - Hatch shales and flags
    - Cashaqua shale
    - West River shale
    - Genundewa limestone
    - Genesee black shale
    - Tully limestone
  - Erian
    - Moscow shale
    - Tichenor limestone
    - Ludlowville shale
    - Skaneateles shale
    - Cardiff shale
    - Marcellus black shale
  - Ulsterian — Onondaga limestone
  - Oriskanian — Oriskany sandstone
- Ontaric or Siluric
  - Cayugan
    - Manlius limestone
    - Rondout waterlime
    - Cobleskill limestone
    - Bertie waterlime
    - Camillus shale

The 21 geologic units into which the surface rocks of these quadrangles are divided have an aggregate thickness approximately of 1920 feet, of which 1080 feet appear in ascending from 380 A. T. in the northwestern corner of the Auburn quadrangle to 1460 A. T. in the southwest corner of the Genoa quadrangle and 840 feet are brought up by the northward elevation of the strata at an average of about 25 feet per mile for the whole distance, though the dip is extremely variable and for a few miles in the southern part of the Genoa quadrangle actually reversed.

FORMATIONS IN ASCENDING ORDER

SILURIC

Camillus shale

This formation is that subdivision of the Salina group which, along the line of outcrop, succeeds the red Vernon shale and at or near the base of which the New York rock salt beds are reached in the deep borings at Tully, Ithaca, Watkins and farther west.

The lower part is composed of thin, somewhat uneven layers of dark dolomite and gray marly shales, and the upper of a bed of gypseous shale 35 to 45 feet thick in which thin limestones like those below occur.

This is the well known "land plaster" or gypsum bed that extends from Madison county to Genesee county, the rock which, when pulverized, was for many years considered valuable and extensively quarried as a fertilizer and one of the most important of the economic resources of the State. At present though fallen into disuse for that purpose, it is utilized as an important component in the production of prepared wall plaster. The formation received its name from the town of Camillus, Onondaga co., where the first discovery of gypsum in the United States was made in the year 1792.

A large number of gypsum quarries were formerly operated in the Camillus in the region on the east side of Cayuga lake north of Union Springs but nearly all of them have been long abandoned and afford only small exposures of the gypsum and overlying li estones. The large quarry of the Cayuga Land Plaster Company, formerly known as the Backus quarry, situated east of the railroad at Cayuga Junction shows very favorably nearly all of the gypsum bed and a few feet of the Bertie waterlime that succeeds it. There are several old pits on Hibiscus point, also near Crossroads, and 1½ miles farther north.

Outcrops of gypsum occur in the banks of both branches of Sawyers creek, and the cliff in the northern part of the village of Cayuga shows the upper part of the bed and the overlying limestone. An old gypsum pit, now nearly obliterated, situated between two drumlins 2 miles north of Cayuga and ½ mile east of the Mud Lock, seems to be the most northern point at which gypsum has been quarried on this quadrangle.

The only fossil known to occur in the Camillus shale, and that very rarely, is the ostracod Leperditia alta Conrad, though obscure traillike markings sometimes seen may owe their origin to another form of animal life.

Bertie waterlime

The gypsum beds are overlain by evenly bedded impure magnesian limestone, medium hard and dark colored when freshly broken, but weathering to a light bluish or yellowish gray on exposure and becoming softer.

Faint deposition lines may be discerned throughout the formation but the heavier layers which are 1 to 2 feet thick are usually quite compact, breaking with a conchoidal fracture, while a few of the others show quite distinct laminations and weather into a hard slaty shale. Toward the west it becomes somewhat thicker and is less homogeneous. In Erie county it is 49 feet thick and the upper part is the cement rock from which a large quantity of natural or waterlime cement is manufactured while the stratum next below is a dark slaty rock.

Waterlime cement was formerly made in the vicinity of Cayuga Junction and near Auburn from outcrops of this rock, but none is made now.

Fossils are rare in this formation as exposed on the Auburn quadrangle, a few Lingulas of two species, an Orbiculoidea, a Rhynchonella with Leperditia alta and fragments of eurypterids constituting the fauna here, but in Erie county the cement rock has afforded a large number of remarkably fine specimens of eurypterids and phyllocarids of the following species:

Ceratiocaris acuminata *Hall*
Eurypterus lacustris *Hall*
E. lacustris *var.* pachycheirus *Hall*
E. remipes *De Kay*
E. pustulosus *Hall*
E. dekayi *Hall*
Dolichopterus macrocheirus *Hall*
Eusarcus scorpionis *Grote & Pitt*
Pterygotus buffaloensis *Pohlman*
P. cobbi *Hall*

Also Leperditia scalaris Jones and a few Orbiculoideas and Lingulas and traces of the seaweed Bythotrephis lesquereuxi Grote and Pitt.

Bertie waterlime was exposed at the top of the wall in nearly all of the old gypsum quarries and small outcrops and loose blocks are still to be found at such localities. It is to be seen at the south end of the quarry at the plaster works; along the railroad at Cayuga Junction and at Crossroads; in several of the old pits near the four corners 1½ miles north of Crossroads and at the top of the wall of the old quarry at Cayuga.

Cobleskill limestone

Succeeding the Bertie waterlime there are three or four layers aggregating 8 to 10 feet of harder, darker limestone that has received the above designation from the favorable exposures of this rock in its most typical condition along Cobleskill creek, Schoharie county, where it has a thickness of 6 feet.

It thins out toward the west, from the Cayuga lake region to Phelps, Ontario co., but reappears farther west and attains its greatest thickness at Falkirk, Erie co., where it is known as the "bullhead" and is 14 feet thick.

On these quadrangles this limestone is seen to the best advantage on Frontenac island at Union Springs where the sharp elevation of the strata toward the north brings the three layers of the formation successively into view. The upper layer has a thickness of 3 feet 2 inches and breaks readily under the hammer into small angular fragments. This is the most fossiliferous layer except in Stromatopora. The middle layer is 2 feet 10 inches thick and contains Stromatopora concentrica Hall in great abundance, and except that it is a little darker colored, it has precisely the same appearance as the Stromatopora layer of the Manlius limestone which is 50 to 60 feet higher in the section.

The lower layer, 2 feet 6 inches thick, weathers to a lighter color than the two upper ones and is less fossiliferous, approaching the character of the upper layers of the Bertie waterlime below it. The thickness of these divisions is probably not maintained for any great distance but the character of the rock is quite uniform.

On the mainland the most southern exposure of this limestone is on the southeast side of Howland point where the upper layers are well displayed.

The old O'Conner quarry, 2 miles north of Union Springs, on the east side of the Cayuga road, shows 4 feet 8 inches of Cobleskill with 6 feet of Bertie below it and the exposure extends several rods north over the remarkable conical uplifts hereinafter further described. The cap layer of the old Wooley quarry on the east side of the road 1 mile south of Crossroads is Cobleskill limestone and it appears at the top of the railroad cut 40 rods east of the station at Crossroads.

At the old Thompson quarries near the four corners 1½ miles north of Crossroads there are several old gypsum pits in which there are small exposures of Bertie waterlime and the Cobleskill outcrops slightly at the roadside 60 yards north of the corners with Bertie below, and it is to be seen in place 125 yards farther west and there are many loose fragments of the more fossiliferous layer near by.

The largest exposure and the one most favorable for examination of the strata and collection of the fossils of this formation on these quadrangles is ⅝ mile southeast of Aurelius station on the New York Central Railroad where an outcropping ledge extends many rods north and south of the road to Aurelius, in which there is an old quarry and the upheaval of a row of rock cones, similar to those previously mentioned as occurring at the O'Conner quarry, has broken and disturbed the heavy layers in an unusual and very striking manner. Two small outliers or rocdrumlins of Cobleskill are located a mile farther north. The New York Central Railroad cuts through the north end of a drumlin 1½ miles northeast of Aurelius station, and another a mile farther east. The surface contour of the Cobleskill may conform to the shape of these hills but the rock does not appear on the surface.

At the foot of the hill next east of the crossing of the road leading north from the village of Aurelius and the New York Central Railroad, a small quarry on the south side of the railroad shows 4 feet 8 inches of Cobleskill at the base of the section and a few feet of Rondout waterlime above it. Manlius and Onondaga limestone outcrop 60 to 80 feet higher at the crest of the hill.

This formation is covered by drift in the region north of Auburn, except possibly a small outcrop by the side of the Lehigh Valley Railroad a mile south of Throop, but it is fairly exposed 8 rods northwest of the Sennett station of the New York Central Railroad and a ledge of the Cobleskill limestone crosses the little brook west of the station 10 rods south of the railroad.

Fossils. The following species have been identified from Frontenac island:

Chaetetes (Monotrypella) arbusculus *Hall*
Favosites niagarensis *Hall?*
Halysites catenulatus (*Linné*)
Stromatopora concentrica *Hall*
Cyathophyllum hydraulicum *Simpson*
Crinoid *sp.*
Chonetes jerseyensis *Weller*
C. undulatus *Hall*
Rhynchonella pisum *Hall & Whitfield*
Spirifer crispus *var.* corallinensis *Grabau*
S. vanuxemi *Hall*
Stropheodonta bipartita *Hall*
S. textilis *Hall*
S. varistriata (*Conrad*)
Whitfieldella sulcata (*Vanuxem*)
Ilionia sinuata *Hall*
Megambonia aviculoidea *Hall*
Pterinea subplana (*Hall*)
Bucania *sp.*
Cyclonema *sp.*
Loxonema *sp.*
Trochoceras gebhardi *Hall*
Tentaculites gyracanthus (*Eaton*)
Gomphoceras septore *Hall*
Orthoceras trusitum *Clarke & Ruedemann*
Orthoceras *large sp.*
Beyrichia *sp.*
Leperditia alta *Conrad?*
L. *cf.* scalaris *Jones*

Rondout waterlime

This formation is composed of dark colored waterlime closely resembling cement rock and shows faint lines of deposition and a tendency to split along these lines. It is 25 to 30 feet thick at Union Springs and increases 10 feet or more in the northeastern part of the quadrangle, and to 45 feet in Onondaga county, but decreases westward to 9 feet at Seneca Falls and is not recognized in the western part of the State.

It is 24 feet thick and the basal layers are extensively quarried for cement at Rondout, Ulster co., N. Y., whence the name of the formation is derived. The contact with the Cobleskill limestone is quite abrupt and is plainly seen where exposed, but at the top the transition to the Manlius limestone is a gradual one and in old exposures not readily discerned.

Rondout waterlime is exposed in the northern part of Union Springs in the gutters of the street leading eastward up the hill opposite the mill pond, and in the old quarry a few rods north of the O'Conner quarry 1¼ miles farther north. It appears at the top of the east end of the cut 50 rods east of the station at Crossroads, and there are several small exposures and numerous blocks of it in the region east of Aurelius station. It may be seen by the side of the New York Central Railroad and along Crane brook a mile west of Auburn. The contact with Cobleskill limestone is shown in the small old quarry at the foot of the hill on the south side of the railroad a mile farther west.

A shallow cut of the Lehigh Valley Railroad 2 miles north of Auburn shows Rondout waterlime and it is well exposed along and near the New York Central Railroad east of Sennett.

Fossils. The fauna of the Rondout waterlime in this region comprises but few species and they are very rare. Leperditia alta Conrad and L. scalaris Jones occur and fragments of eurypterids are occasionally found.

Manlius limestone

This formation, formerly well known as Tentaculite limestone, is 77 feet thick at Manlius, Onondaga co., but it diminishes rapidly toward the west and disappears in the vicinity of Seneca Falls.

It is composed of a series of distinct layers of hard, dark blue limestone from 2 to 5 feet thick, separated by thin partings of black bituminous matter. Some of these layers are quite compact and the lines of deposition are faint, but in others the rock has a straticulate appearance due to an alternation of thin plates of dark bituminous limestone and lighter colored impure limestone or waterlime. The laminations are from ¼ to 2 inches thick and exposure makes the contrast more noticeable.

The rock splits easily along the lines of deposition and breaks into angular blocks making it valuable for building purposes and road metal.

It is exposed to the thickness of 18 feet 8 inches in the extreme southern quarry on the east side of the Lehigh Valley Railroad a mile south of Union Springs, where it is separated into five distinct layers, with Onondaga limestone above, separated from it by a thin uneven band of dark material representing the Oriskany sandstone.

In the upper bed, 4 feet 5 inches thick, the rock is blue gray with faint lines of deposition and few fossils. The next bed in descending order is 5 feet 3 inches thick and contains Stromatopora concentrica Hall abundantly, making the limestone somewhat purer and harder than the adjacent layers.

This stratum possesses the same condition eastward across Cayuga and Onondaga counties and is well known as the upper Stromatopora layer, a stratum of almost precisely the same appearance in the Cobleskill limestone on this quadrangle and farther west being distinguished as the lower Stromatopora layer.

The stratum next below, 3 feet 1 inch thick, contains the fossil less abundantly and it is absent in the two lower tiers.

Manlius limestone is also exposed in the ravine in the rear of the sanatorium in the village of Union Springs and in the old quarry near the residence of Mr George Backus 1 mile north of the village from which a large amount has been utilized in building inclosure walls along the highway in the vicinity. The upper beds have been quarried on the Yawger farm 3 miles northeast of Union Springs where they are overlaid by 4 feet 6 inches of Oriskany sandstone, and the formation outcrops half a mile farther north on a hill on the east side of the highway leading to Crossroads. A quarry half a mile west of the Lehigh Valley Railroad station in the city of Auburn shows Manlius limestone at the bottom at the north end with Oriskany sandstone and Onondaga limestone above it. Nearly all of the large quarries in the face of the rock escarpment that extends across the northern part of the city are in the Manlius, with Oriskany at or near the top of the section. The old Phelps quarry on the east side of the highway 2 miles south of the village of Sennett displays the formation finely and several abandoned quarries near the northeast corner of the quadrangle afford most excellent opportunity for examination of the stratigraphy and the fauna of this the highest member of the Siluric system on the Auburn quadrangle.

Fossils are common throughout the formation and very abundant in some parts. The number of species is quite limited, however, the fauna in this locality, so far as observed, consisting of the following:

Chaetetes (Monotrypella) arbusculus *Hall*
Stromatopora concentrica *Conrad*
Schuchertella interstriata *Hall*
Spirifer vanuxemi *Hall*
Stropheodonta varistriata (*Conrad*)
Whitfieldella laevis (*Vanuxem*)
W. sulcata (*Vanuxem*)
Holopea antiqua *Vanuxem*
Tentaculites *sp.*
Leperditia alta *Conrad*

DEVONIC

Oriskany sandstone

The basal member of the Devonic system, interstratified between the Manlius limestone and the Onondaga limestone in the central and western parts of the State is an intermitting stratum or series of thin lentils, of coarse pinkish or white sandstone or quartzite, or where these are wanting, a thin mass of black bituminous mud with pebbles of black sand or waterlime. At some outcrops these pebbles occur embedded in the lower part of the heavy layer of limestone that succeeds this horizon.

The line of outcrops of this horizon shows cross sections of the sandstone lentils west of this locality to be quite thin, one exposed in the village of Phelps that measures 6 feet 6 inches being the thickest, and one penetrated by the Livonia salt shaft 4 feet 9 inches thick. The thickness increases eastward attaining 25 feet in a lentil in the western part of Onondaga county and the formation is well developed in the vicinity of Oriskany Falls, whence the name, first applied by Vanuxem in his report on the Geological Survey of the Third District for 1839.

In the Oriskany horizon in the old Shaliboo quarry 1 mile south of Union Springs there are 10 inches of dark conglomerate composed of bituminous shale in which there are embedded many pebbles and fragments of waterlime. A stratum of calcareous sandstone 1 foot 6 inches thick, exposed on the north side of the bridge on Center street in Union Springs in which there are many pebbles, represents this formation. An outcrop of typical Oriskany sandstone 2 feet 3 inches thick and containing many fossils occurs on a knoll a few rods south of the residence of Mr George D. Backus. An old quarry in the woods 50 rods west of the Yawger cemetery 1½ miles northeast of Union Springs shows 9 feet of friable pinkish sandstone in three layers, all fossiliferous, the lower one 4 feet thick being fairly crowded with large brachiopods.

In the woods on the Yawger farm ¾ mile north of the cemetery, a ledge extending in a north and south direction 35 to 40 rods, shows Oriskany sandstone 5 feet 6 inches thick in the central part and extraordinarily fossiliferous. Vanuxem refers to this locality on page 127 of the report on the Third District, 1842, and says of it: "The fossils are numerous, and better preserved than in any other locality of the district, state or country that has come to our knowledge, the rock being more solid and the sand of which it is composed purer and whiter."

Where exposed in the western part of the ledge at the crest of the hill 1¾ miles north of Aurelius it is 2 feet 1 inch thick in ordinary condition and has many fossils in the lower part of the stratum. It is 10 to 12 inches thick in the old quarries in the northern part of Auburn west of the crossing of North street and the New York Central Railroad, and a small outcrop near the northeast corner of the quadrangle shows about the same thickness.

The occurrence of the fossils of large size and in some outcrops, as north of Union Springs, in great abundance, tends to produce the impression that the fauna of the sandstone in this region is a large one,

but the number of species is quite limited. The more prominent and persistent forms occurring in this rock in the central part of New York are:

Spirifer arenosus (*Conrad*)
S. murchisoni *Castelnau*
Rensselaeria ovoides (*Eaton*)
Hipparionyx proximus *Vanuxem*
Chonostrophia complanata *Hall*
Meristella lata *Hall*

Onondaga limestone

The heavy beds of bluish gray limestone with embedded nodules and nodular layers of chert or hornstone overlying the Oriskany sandstone and succeeded by the black Marcellus shales, was designated "Cornitiferous limestone" by Prof. Amos Eaton in 1839, and in the early reports of the Geological Survey was considered in two divisions. The basal member, which is usually free from chert and but a few feet thick is the "grey sparry limestone" of the annual reports. In his report on the Fourth Geological District (1839) James Hall first used the term Onondaga limestone, applying it to this basal division of the formation. The overlying cherty beds composed the "Seneca limestone" of the early reports and the "Corniferous limestone" of the final reports of Hall and Vanuxem in 1842.

The name "Onondaga Salt Group," applied to the Vernon and Camillus shales, was used in the annual and final reports of the Geological Survey but discontinued some years after. In Clarke and Schuchert's revised "Classification of the New York Geologic Formations" the term Onondaga limestone is expanded to include all of the strata between the Oriskany horizon and the Marcellus black shales.[1]

The limestone is usually separated by thin partings of shale or bituminous mud into even compact layers or tiers from 6 inches to 3 feet thick, some of which are nearly or quite free from chert and are valuable as building stone, while others contain a considerable proportion of the flint or hornstone and are utilized extensively when crushed as road material. Shaly tiers occur at some localities but the beds are mostly compact. The hundreds of quarries in the Onondaga limestone along its line of outcrops from the Hudson valley to the Niagara river attest its importance among the economic resources of the State and show the enormous amount of this rock that has been and is still being utilized.

[1] For a more detailed history of the names applied to this formation see State Museum Bulletin 128.

On the Auburn quadrangle quarry walls and field outcrops make an almost continuous series of exposures of the Onondaga extending from the extreme western point of Long point on Cayuga lake to the northeast corner of the quadrangle. Fifteen feet of the lower beds and the Oriskany contact are well shown in the old Shaliboo quarry a mile south of Union Springs. The next quarry at the north between the railroad and the highway exposes 40 to 50 feet of the middle and upper tiers and the old Wood quarry on the hill east of the highway affords a long exposure of the upper beds, with the contact line and 15 feet of Marcellus black shale and impure limestone at the top of the quarry wall.

Owing to the northward dip of the strata at this point the newer quarry at the north on the east side of the road, though about 25 feet lower, shows the same section and it is also shown in a large quarry on the hill a mile east of Union Springs.

The drift sheet is thin over all the region between Union Springs and Auburn where the Onondaga limestone is the surface rock and outcrops are frequent. The lower beds are exposed just north of Oakwood and the top layers in the hill 3/8 mile south of Half Acre. In the vicinity of Aurelius there are broad areas where the limestone is but partially covered and a ledge 50 rods long at the crest of the hill on the south side of the railroad 2 miles north of Aurelius exposes the Oriskany contact and 15 to 25 feet of the lower beds.

It lies near the surface and is exposed in numerous places in the northern parts of Auburn and thence northeastward in many quarries and field outcrops in the vicinity of the New York Central Railroad to the east line of the quadrangle.

Fossils are exceedingly abundant in nearly all parts of the limestone layers and occur frequently in the chert and the shaly partings. A list of the species contained in this formation published in State Museum Bulletin 63 for the Canandaigua-Naples quadrangles includes 3 fishes, 39 crustaceans, 13 cephalopods, 3 pteropods, 38 gastropods, 15 lamellibranchs, 48 brachiopods, 4 crinoids and 30 corals, a total of 193 species.

Marcellus black shale

On page 146 of the report on the Geological Survey of the Third District, 1842, Vanuxem describes the Marcellus shales under two divisions: the "lower, calcareous, fossiliferous, and somewhat fissile; the upper, shaly, breaking into small irregular fragments" and further says: "These shales extend east and west through the district commencing near the Hudson and ending on Lake Erie. They are con-

veniently divided into two masses, from the presence of limestone and fossils in the one and their absence in the other."

On page 177 of the report on the Fourth District, Hall describes the lower division and adds: "This division terminates upward by a thin band of limestone above which the shale is more fissile and gradually passes from black to an olive or dark slate color."

The limestone here referred to is now known as the Stafford limestone. It is 8 to 10 feet thick in Erie county and diminishes gradually to 4 inches on Flint creek in Ontario county. This hard limestone layer is not found in exposures of this horizon east of Flint creek but a band of gray calcareous shale containing many species belonging to the fauna of the Stafford limestone, and that are absent from or very rare in the adjacent shale, serves to mark the point of separation between the two divisions of these dark shales.

The term Marcellus black shale as now used applies only to the lower division, succeeding the Onondaga limestone and overlaid by the Stafford limestone or in its absence, the lighter shales of the second division now known as the Cardiff shales. Its thickness is 45 to 50 feet on the Auburn quadrangle.

The change is abrupt from the blue Onondaga limestone to the black Marcellus shales in Madison and Onondaga counties but a few thin calcareous layers are interstratified in the succeeding 13 feet and a hard stratum 2 to 3 feet thick, known to geologists as the Agoniatite limestone occurring at this horizon, is a persistent and easily recognized feature of the Marcellus section from Schoharie county to the town of Phelps, Ontario co., where it is finely exposed in the bed of Flint creek.

The shales that intervene between the Onondaga and the Agoniatite layer in eastern central New York become more calcareous toward the west and on this quadrangle this bed is composed principally of impure limestones in layers a few inches thick with partings of black shale, and a 5 inch stratum of shale at the base. At the exposure in the bed of Flint creek the proportion of calcareous matter is still larger and in the western part of the State the Agoniatite layer and the strata below it have become so far assimilated to the Onondaga limestone as not to be readily distinguished from it.

The remaining upper part of this formation is a bed of black shale the only notable feature of which is a row of spherical concretions 2 to 3 feet in diameter found in this horizon wherever exposed in the central and western part of the State.

Exposures. The black upper shales with large concretions are exposed by the lake shore on the east side of the Lehigh Valley Railroad 1¼ miles north of Levanna. The Agoniatite limestone with 15 feet of black shale above it and the impure limestone layers below, down to the Onondaga limestone, are finely displayed in the upper part of the old Wood quarry a mile south of Union Springs and the lower impure limestones in Wood's new quarry and the Smith quarry 1 mile east of Union Springs also.

The Agoniatite layer outcrops slightly by the roadside a mile east of Half Acre and the black upper beds are displayed in the new railroad cut half a mile farther east.

Marcellus shale crops out slightly in the bed of the stream ¼ mile north of Soule's cemetery on the Auburn Road (N. Y. C. & H. R. R. R.) 3½ miles east of Auburn and 2 miles northeast of the city in the bank of a small ravine that crosses the road leading from Grant avenue to Franklin street. The large concretions are seen here. The Agoniatite limestone and adjacent black shales outcrop ¼ mile from the east line of the quadrangle by the side of the third east and west road from the north line of the quadrangle.

Fossils. The lower shales contain:

Orthoceras subulatum *Hall*
Styliolina fissurella (*Hall*)
Pleurotomaria rugulata *Hall*
Liorhynchus limitare (*Vanuxem*)
L. laura *Billings*
Strophalosia truncata *Hall*
Ambocoelia umbonata (*Conrad*)
Chonetes mucronatus *Hall*
C. lepidus *Hall*
Orbiculoidea media *Hall*
Pterochaenia fragile (*Hall*)
Liopteria laevis (*Hall*)
Nuculites oblongatus *Conrad*
Panenka ventricosa *Hall*

A list of 28 species found in the Agoniatite limestone in Onondaga and Schoharie counties may be found in State Museum Bulletin 49, but the stratum appears to be less fossiliferous here. Fragments of the large cephalopod Agoniatites expansus (Vanuxem) occur in this layer at Wood's old quarry, Union Springs.

Cardiff shale

The Stafford limestone being absent from these quadrangles the Marcellus shale is succeeded by about 50 feet of dark shale until recently known as the upper Marcellus shale. In State Museum Bulletin 63, published in 1904, this formation was designated by

the above name on account of its abundant exposure in the vicinity of the village of Cardiff in Onondaga county.

It is composed of soft shales varying in character from medium light colored and calcareous to very dark and bituminous. It contains a row of medium sized spherical concretions and toward the top, thin calcareous lentils composed mainly of Liorhynchus limitare.

At the base a bed of rather light colored shale in the horizon of the Stafford limestone is quite calcareous and contains many fossils most of which are common in the limestone in the western part of the State.

The upper beds are darker, and in some parts quite black and bituminous, and less fossiliferous. Near the top a band of very hard, dark calcareous shale or impure limestone that is continuous across this quadrangle and to Seneca lake, produces cascades in Great gully and Criss creek south of Union Springs. The succeeding shales above this stratum gradually become lighter colored and more argillaceous and pass into the next formation in the series, the Skaneateles shale.

Exposures. The Cardiff shale and the hard layer are exposed along the lake shore half a mile north of Levanna, the hard layer rising from the lake level in a bluff that reaches the hight of 12 feet, then with an eight per cent northward dip sinks below the lake to emerge again 15 rods farther north and rise rapidly in the 25 foot bluff that exposes also the dark shales with fossils immediately below it. The hard stratum produces a cascade at the bridge over the next stream south of Great Gully brook (Criss creek), with dark fossiliferous shales below it, and the gray fossiliferous band at the base of the formation is exposed in the bank of this creek north of the crossing of the private road ¼ mile farther north. In Great gully the hard layer appears at the crest of a cascade 6 feet high at the mouth of the ravine, 25 rods west from the lake road and, rising toward the east more rapidly than the bed of the stream, is at the crest of a second fall 5 feet high, and 50 rods up the ravine at the top of a third fall 17 feet high.

This stratum, with adjacent shales, outcrops by the roadside near the four corners on the hill 1½ miles south of Oakwood and also along the new railroad from Auburn southward through Genoa, 1½ miles south of Auburn.

Fossils. A full list of the fossils of the Stafford limestone and the Cardiff shale may be found in State Museum Bulletin 63.

The collector may expect to find the following species in the Cardiff beds south of Union Springs:

Phacops rana *Green*
Cryphaeus boothi *Green*
Homalonotus dekayi *Green*
Orthoceras subulatum *Hall*
Tornoceras discoideum (*Conrad*)
Tentaculites gracilistriatus *Hall*
Styliolina fissurella (*Hall*)
Pleurotomaria rugulata *Hall*
P. itys *Hall*
P. capillaria *Conrad*
P. sulcomarginata *Conrad*
Camarotoechia sappho *Hall*
Spirifer audaculus *Conrad*
Strophalosia truncata *Hall*
Productella spinulicosta *Hall*
Chonetes mucronatus *Hall*
C. scitulus *Hall*
Liorhynchus limitare (*Vanuxem*)
Ambocoelia umbonata (*Conrad*)
Orbiculoidea minuta *Hall*

Skaneateles shale

This name was applied to the beds next above the Cardiff as they appear near the foot of Skaneateles lake, by Vanuxem in his annual report for 1839; and in his final report on the Third District, 1842, it is mentioned as the first or lowest member of the Hamilton group.

It is a mass of dark soft clayey shale with some beds of black shale interbedded but gradually assuming on the whole a lighter color toward the top and contains some thin calcareous lenses composed of fossils and occasional concretions. The lines of contact with the adjacent formations are not clearly defined but on this quadrangle the Skaneateles beds have an estimated thickness of 200 feet. They are well exposed along the railroad between Aurora and Levanna and in the ravines of Glen creek, Criss creek and in Great Gully brook, also slightly just east of Fleming.

Fossils are not so abundant in the Skaneateles shale as in the succeeding Ludlowville beds. The following is a partial list of the species that may be found in this formation on these quadrangles:

Ambocoelia umbonata (*Conrad*)
Tropidoleptus coronatus (*Conrad*)
Athyris spiriferoides (*Eaton*)
Leptostrophia perplana (*Conrad*)
Orbiculoidea media *Hall*
Chonetes coronatus *Hall*
C. mucronatus *Hall*
Spirifer audaculus *Conrad*
Productella spinulicosta *Hall*
Grammysia arcuata *Conrad*
Pterochaenia fragilis (*Hall*)
Actinopteria boydi *Hall*
Modiomorpha subalata (*Conrad*)
Buchiola retrostriata (*von Buch*)
Nuculites corbuliformis *Hall*
Styliolina fissurella (*Hall*)
Tornoceras discoideum (*Conrad*)
Orthoceras subulatum *Hall*
Cryphaeus boothi *Green*
Phacops rana *Green*

Ludlowville shale

Next above the Skaneateles beds there are about 25 feet of lighter colored, sandy shales somewhat calcareous and harder than the beds below and above. This band is abundantly fossiliferous containing many large brachiopods and cyathophylloid corals. It is continuous across this quadrangle and westward, with an increasing proportion of calcareous matter and fossils to Ontario county, appearing at Centerfield, 5 miles west of Canandaigua as a distinct stratum of limestone largely composed of corals.

It is succeeded here by about 100 feet of soft dark shales similar in character to the Skaneateles and containing a somewhat similar fauna.

The upper beds gradually become more sandy, lighter colored and fossiliferous. Thin calcareous lenses, masses of crinoid stems and other fossils occur and there are many small concretions.

The formation is terminated at the top by a continuous layer of crinoidal limestone, formerly the "encrinal limestone," now known as the Tichenor limestone.

These beds were first designated Ludlowville shales by Professor Hall in his report on the geology of the Fourth District (for 1838) 1839.

Exposures. The upper and more fossiliferous part of this formation is exposed along the east side of the Lehigh Valley Railroad for nearly a mile in the vicinity of Portland (or Shurger) point, and also to the thickness of 25 feet in the north bank of Salmon creek a mile below Ludlowville. It is below the lake level from the north side of Myers point to Atwaters, but is abundantly displayed in the cliff and ravines along the lake shore and railroad, almost the entire distance between Atwaters and Stony point, the upper beds being most conveniently exposed in the vicinity of King Ferry, and the lower fossiliferous band at Willetts and Stony point.

The soft shales of the middle portion of the formation appear in walls of the ravine of Payne's creek and the upper beds capped by the Tichenor limestone at the falls.

There are many outcrops of Ludlowville shale in the small ravines north of Aurora and on the crest of the ridge 2 to 4 miles south of Fleming. The lower beds are finely exposed along the road ½ mile southwest from Wykoff and the ravine at Ensenore displays almost the entire Ludlowville section and there are fine exposures along the railroad north and south of Ensenore.

The fauna of the Ludlowville shale is a very large one. For list of species see State Museum Bulletin 63 under Canandaigua shale and Bulletin 99.

Tichenor limestone

A stratum of hard bluish gray limestone 10 to 14 inches thick overlies the Ludlowville shale at all exposures of this horizon from Onondaga county to Lake Erie, showing little variation in character though its fossils are much more abundant and better preserved at some exposures than at others.

It usually is composed largely of crinoid stems, and for this reason received the designation Encrinal limestone from Hall in his annual report on the geology of the Fourth District (for 1838) 1839 and by which it was known until the term Tichenor limestone was applied to it by Clarke in State Museum Handbook 19, from its favorable exposure in Tichenor gully on the west shore of Canandaigua lake. In the southern part of the Genoa quadrangle, in addition to the hard layer, there are 2 to 3 feet of hard calcareous shale and thin limestones that clearly belong to this division.

The most southern exposure of the Tichenor limestone in the Cayuga lake valley is on the east side of the Lehigh Valley Railroad 25 rods south of the cement factory at Portland or Shurger point. It is here a calcareous band 2 feet 9 inches thick, the upper part 18 inches thick being quite hard and compact and the remainder, except a few thin layers, quite shaly.

There are two thin limestones of similar character 5 and 7 feet higher, and the Ludlowville shales below are highly calcareous and fossiliferous. In Shurgers glen the hard layer is exposed at the top of the falls 50 feet above the lake level and in some places contains masses of crinoid stems 8 to 10 inches thick.

It appears 45 feet above the lake level in a small ravine 3/8 mile north of Portland and in the north bank of Salmon creek at Myers 20 feet higher than the lake.

It is above lake level for a few rods at the mouth of Willow creek on the west side of the lake, but is submerged from that point to Kidders where it emerges and rising rapidly toward the north and west produces the lower falls in the ravines of Sheldrake, Groves and Barnum creeks.

On the east side it emerges at Atwaters and is well exposed along the railroad and in several ravines between Atwaters and King Ferry. In the ravine at the latter place it forms the crest of the second falls, 30 feet above the lake, and is also at the top of high falls in three ravines near the lake north of King Ferry.

It forms the crest of the falls in the ravine of Paynes creek and rising toward the southeast, appears in the bed of the stream several times between the falls and the forks of the creek.

No outcrops of the Tichenor are known on the gently sloping higher part of the ridge between the lakes, but it is finely exposed at the top of a fall in the Ensenore ravine 20 rods below the first highway bridge over the stream west of the station. It is very rich in fossils here, specially large trilobites and brachiopods, and there are several characteristic masses of crinoid columns.

It appears similarly situated and in the same condition in several ravines south of Ensenore.

The fossils found in the Tichenor limestone are members of the Hamilton fauna and of the same species as occur in the Ludlowville and Moscow shales. For list see State Museum Bulletins 69 and 99.

Moscow shale

The stratigraphic position of this formation is well defined on this quadrangle by the Tichenor limestone at the base and the Tully limestone at the top, both of which show a marked contrast to the medium dark gray soft shales of which it is composed, the few thin calcareous lentils interstratified with the shales not being of sufficient importance to cause any difficulty of identification. It has a thickness of 130 feet.

The light colored middle and lower parts contain fossils in great abundance, but in the darker upper beds they are comparatively rare. For details of the fauna of the Moscow shale see State Museum Bulletin 63.

On the west side of Cayuga lake the large ravines of Bloomer, Grove and Sheldrake creeks cut through the Moscow shale and the numerous small ravines south of Kidders and the shore cliffs as far as Little point show the upper beds to good advantage, and the entire section is displayed between Taghanic point and a mile from the south line of the quadrangle.

On the east side of the lake, exposures of Moscow shale begin half a mile from the south line of the quadrangle and, except for 1¼ miles south of Lansing where it is below the lake level, appear in all of the ravines and shore cliffs for 12 miles toward the north to near King Ferry (Clearview) and in the upper part of several ravines farther north, also in the Paynes creek ravine and the one below Chapel Corners.

The more accessible and favorable exposures of the entire section are: along the railroad south of Portland point; in Shurgers glen and the Salmon creek ravine; the ravines near Atwaters and King Ferry also show the whole section.

There are but few outcrops of the Moscow shale in the Owasco lake valley within the limits of the Genoa quadrangle but a few miles farther south in the ravines near Moravia the formation is well exposed.

Tully limestone

From near the west shore of Canandaigua lake in the town of Gorham, Ontario co., to Smyrna, Chenango co., a hundred miles east, the Moscow shales are overlain by the Tully limestone, so named by Vanuxem in his report on the geology of the Third District for 1838.

On these quadrangles the formation is composed of four to six compact layers of fine grained blue black limestone that weathers to a light gray or ashen color and has an aggregate thickness varying between 14 and 21 feet. The rock is very hard when fresh but after long exposure breaks easily into small angular fragments. The basal layer which is very hard is 7 to 9 feet thick at some exposures, the others varying from 1 to 4 feet. Frequent joints divide the strata into large blocks that become detached and are strewn along the lake shores at the base of cliffs in which the limestone occurs and in the bottom of many ravines below cascades produced by it.

The passage from the soft Moscow shale to the base of the limestone is very abrupt but at the top the overlying Genesee shale is quite calcareous for a few feet.

At the top of the low fall where Taghanic creek flows over the limestone at Taghanic point the normal Tully is overlain by 2 feet 4 inches of dark impure limestone succeeded by about the same thickness of densely black Genesee shale that is succeeded by a 12 inch stratum of dark limestone exposed in the sides and bottom of the stream for about half a mile. As the few fossils in these calcareous layers are of species common in the Genesee shales they are assigned to that formation.

Exposures. The Tully limestone is exposed for several miles in the cliffs along the shores of Cayuga lake and in a large number of ravines cut in the hills it forms the crests of falls or cascades and appears in the rock walls, the hard light colored limestone projecting from the dark soft shales and producing the most striking and picturesque effects.

It emerges, forming a low cliff, on the west side of the lake ¾ mile from the south line of the quadrangle, rises rapidly to 144 feet above lake level in Willow creek, then descends to lake level half a mile north of Taghanic point. It is submerged for 3½ miles, then appears in a cliff to Little point and in all the ravines to Barnum creek where

it is seen at the top of falls near the west line of the quadrangle 300 feet higher than the lake.

On the east side the top of the Tully is at lake level at a small point ½ mile from the south line of the Genoa quadrangle, but is covered by beach sand and gravel for 35 rods, then appears between the lake and the railroad, the lower layers submerged at the south end of the exposure but above the water 25 rods farther north. It is displayed in the cliff on the east side of the railroad for ⅛ mile and rises to 640 A. T. in the field ¼ mile north of Shurgers glen, in the vicinity of which it is well exposed in the quarry of the Portland Cement Company and adjacent fields and ravines.

It is at the top of the falls of Salmon creek at Ludlowville and appears at the top of the cliffs on the lake shore ½ mile north of Myers point, and almost continuously for 3 miles, sinking with a northward dip to partial submergence in the lake, then slowly rising, may be seen in the shore cliffs and at the top of falls in several ravines near the lake in an almost continuous exposure for 10 miles to King Ferry (Clearview).

The falls in some of the larger ravines are made exceedingly interesting and picturesque by the disintegration of the soft Moscow shales beneath the limestone which projects so far as to produce recesses or caves of considerable extent. One near the railroad a mile south of Lansing is 50 feet wide and 27 feet deep and there are others not much less extensive. Immense blocks of the limestone partly fill the ravines below the falls producing different but equally striking and rugged effects. The limestone rises rapidly and recedes from the lake shore north of King Ferry outcropping at 800 A. T. on the Aurora road and at the top of falls in two branches of Paynes creek.

It is well exposed at 830 to 850 feet in the ravine at Chapel Corners. This is the extreme northern outcrop of the limestone in the Cayuga lake valley and from this point to an outcrop in the highway near the four corners a mile north of Scipio its precise position is not known. It produces a cascade at 1160 A. T. in the Ensenore brook 1¼ miles farther south.

The limestone is 14 to 15 feet thick in the Barnum and Groves creek ravines, 17 feet 6 inches on Willow creek; 21 feet in Shurgers glen; 18 feet in the Portland Cement Company's quarry and 15 feet at Lake Ridge.

The Tully is usually found to be only moderately fossiliferous but there have been collected from the exposures in the Cayuga lake valley 70 species, of which 14 are corals, 26 brachiopods, 5 lamellibranchs, 15

gastropods, 8 cephalopods and 2 trilobites, besides crinoid stems and unidentified corals.

For list of species see Sixth Annual Report of the State Geologist, 1887.

Genesee black shale

This term was formerly used to designate all of the thick mass of black and dark shale that succeeds the Tully limestone, up to the base of the light colored Cashaqua shale, but for reasons fully set forth in State Museum Bulletin 118, it is now applied only to the more densely black and bituminous lower beds that lie between the Tully limestone and a thin but well defined, calcareous band known as the Genundewa limestone that from Ontario county westward to Lake Erie separates the beds formerly called the lower Genesee shales from the somewhat lighter colored and more calcareous upper Genesee shales.

The limestone is absent in the Cayuga lake valley but the upper limit of the Genesee shale is well marked by an abrupt change to a light gray calcareous shale in the place of the limestone. Two hard layers 1 foot 6 inches and 12 inches thick near the base of the Genesee in the southern part of the Genoa quadrangle are impure limestone but as the few fossils they contain are of the species found in the higher beds, they are, as previously stated, classified as Genesee. There are also a few calcareous concretions but otherwise this formation is quite uniform in character from bottom to top. Though fissile after exposure the rock when fresh is compact and quite hard, and is less susceptible to erosion than more clayey shales. The beds are usually traversed in two or more directions by vertical joints that divide the surface in small square, triangular or diamond shaped tesselations 1 to 3 or 4 feet across.

Fossils are not abundant in the Genesee shale but the collector may expect to find:

Liorhynchus quadricostatum *Hall*
Chonetes lepidus *Hall*
Lingula spatulata *Hall*
Orbiculoidea lodensis (*Vanuxem*)
Pterochaenia fragilis (*Hall*)
Pleurotomaria rugulata *Hall*
Styliolina fissurella (*Hall*)
Tentaculites gracilistriatus *Hall*
Probeloceras lutheri *Clarke*
Bactrites aciculum (*Hall*)

The Genesee shales are exposed in the cliffs on the east side of the lake near the south line of the quadrangle and at most of the exposures of Tully limestone previously mentioned. This formation attains its greatest thickness in this State, about 100 feet, in Ontario

and Yates counties. It diminishes westward to 1 foot on the shore of Lake Erie and eastward to 65 feet on the Genoa quadrangle and is not known east of Smyrna, Chenango co.

Genundewa limestone

This formation which is fully described in State Museum Bulletins 63 and 118, is a band of thin limestones and calcareous shale extending from Gorham, Ontario co. to Lake Erie. The limestones are composed in a large proportion of the shells of the minute pteropod Styliolina fissurella (Hall) and was formerly known as the Styliola limestone. Except in a few small patches the limestone does not appear in characteristic condition in the Seneca lake valley, but its position is clearly indicated by a band of light gray calcareous shale containing a row of large concretions. Fossils common to the limestone farther west, particularly Styliolina fissurella, are abundant in both shales and concretions, [*see* State Mus. Bul. 128]. The formation is less clearly defined in the Cayuga lake valley but may be seen in the rock wall at the Trumansburg creek falls at Frontenac point and at Taghanic Falls.

On the east side of the lake it appears as a rather faint gray band in the cliffs near the south line of the quadrangle about 30 feet below the heavy sandstone that here marks the base of the Cashaqua shales.

The shale is darker, the concretions smaller and fossils more rare here but in the southern part of the Salmon creek valley it is more calcareous and fossils are more common.

It is exposed at the top of the falls in the ravine 2½ miles northeast of Ludlowville and in a 10 foot cliff on the west side of Salmon creek 20 rods north of the highway, 1 mile south of the forks of the creek. At this exposure the bed of the stream is black shale in which Orbiculoidea lodensis, Liorhynchus quadricostatum, Chonetes lepidus and other Genesee fossils are common, and the gray band about 10 feet thick with a row of concretions 1 to 2 feet in diameter and 5 to 8 feet apart at the base, succeeded by 1 foot 8 inches of soft gray shale and a harder stratum of calcareous shale 8 inches thick that is followed by 6 feet of gray shale. This horizon is exposed in 3 ravines on the east side of Salmon creek valley between Genoa and Venice Center, but the formation is not so clearly defined, the overlying shales, which are dark to black in the Seneca lake valley, differing but little here in appearance from these beds.

The following fossils have been found in this gray band in exposures in the Seneca lake and Cayuga lake valleys:

Manticoceras pattersoni (*Hall*)
Gomphoceras *cf.* manes *Hall*
Bactrites *sp.*
Paleotrochus praecursor *Clarke*
Pleurotomaria capillaria *Hall*
Loxonema noe *Clarke*
Styliolina fissurella (*Hall*)
Buchiola retrostriata (*von Buch*)
Palaeoneilo muta *Hall*
Pterochaenia fragilis (*Hall*)
Atrypa reticularis (*Linnê*)
Ambocoelia unbonata (*Conrad*)
Chonetes scitulus *Hall*
Liorhynchus multicostatum (*Hall*)
Orbiculoidea lodensis *Vanuxem*
Lingula spatulata *Vanuxem*
Cladochonus, abundant in concretions
Crinoid stems

West River dark shale

In Ontario county and westward to Lake Erie the dark shales between the Genundewa limestone and the base of the Cashaqua shales are separable into two divisions: the West River shale, a heavy bed of soft dark colored slightly calcareous shales, and succeeding them, the blacker and more bituminous Middlesex shale.

In the Seneca lake valley the distinction between the two formations is scarcely recognizable and in the Cayuga lake valley it seems to be lost entirely and both formations by gradual change in the character of the sedimentation become so far assimilated to the succeeding Cashaqua shale that they are not to be distinguished from that formation east of this, or at farthest, the Moravia quadrangle. The horizon of the West River and Middlesex shales is exposed in the upper part of the Sheldrake and other ravines in that vicinity, also in the Trumansburg and Taghanic ravines and others in the vicinity of Heddens and King Ferry. In the Salmon creek valley these beds may be seen at the top of the falls in the ravine 2¼ miles north of Ludlowville, and in several gullies on the east side between Genoa and Venice Center.

Fossils are very rare in these beds but a few forms like those in the Genesee beds occur. Among these are:

Bactrites aciculum (*Hall*)
Gephyroceras *sp.*
Pterochaenia fragilis (*Hall*)
Lunulicardium curtum *Hall*
Buchiola retrostriata (*von Buch*)
Panenka *sp.*
Lingula spatulata *Vanuxem*
Orbiculoidea lodensis *Vanuxem*
Liorhynchus quadricostatum *Hall*

Cashaqua shale

This formation was named from its favorable exposure along Cashaqua creek, one of the tributaries of the Genesee river in Livingston county. In that locality it is composed almost entirely of light blue gray or olive shale, but toward the east it acquires a slowly increasing proportion of arenaceous matter and on this quadrangle there are frequent flags and thin sandstones, specially in the upper beds where some of the latter are 1 to 3 feet thick and usually schistose to a degree that makes them valuable for flagging, for which purpose they have been extensively quarried on both sides of the Cayuga lake valley.

Except that the shales in the lower part of the formation are rather less calcareous here than they are in the Genesee valley they are of much the same appearance and character.

The upper limit is at the top of a band of soft dark shale about 265 feet above the base and approximately, at least, in the horizon of the Rhinestreet shale that contains a few small lamellibranchs like those below and is succeeded by more arenaceous sediments that carry an abundant brachiopodous fauna.

The Cashaqua beds are exposed in the ravines between Heddens and Clearview and similarly on the opposite side of the lake, also farther north in the Trumansburg and Taghanic creek ravines. The upper flaggy beds are displayed in a number of large quarries now mostly abandoned between Taghanic Falls and Ovid Center, also at Goodyears and King Ferry. The lower beds appear in the ravines on the east side of the Salmon creek valley north of Genoa and along the west branch of Salmon creek in the vicinity of Little Hollow.

Fossils. The lower soft shales contain, though not abundantly, some members of the characteristic fauna of the Cashaqua beds farther west, viz:

Pterochaenia fragilis (*Hall*)
Buchiola retrostriata (*von Buch*)
Probeloceras lutheri *Clarke*
Bactrites aciculum (*Hall*)
Spirifer laevis *Hall* occurs at Taghanic Falls near the top of the lower beds

A thin layer of soft sandstone 35 feet higher exposed in Hunt's quarry 1½ miles southeast of Interlaken contains:

Spirifer mesacostalis *Hall*
Productella spinulicosta *Hall*
Camarotoechia congregata (*Conrad*)
Chonetes lepidus *Hall*
Palaeoeilo constricta (*Conrad*)
Leptodesma *sp.*
Conularia *cf.* continens *Hall*
Helianthaster gyalum *Clarke*
Stictopora
Melocrinus *sp.*
Plumalina

Burls in the higher sandstones contain:

Manticoceras pattersoni (*Hall*)
Orthoceras bebryx *Hall*
Liorhynchus mesacostale *Hall*
Cyrtina hamiltonensis *Hall*
Orbiculoidea *sp.*
Leptostrophia mucronata (*Conrad*)
Grammysia subarcuata *Hall*
Cladochonus *sp.*

and masses of plant remains in which fragments of Lepidodendron are frequent. A considerable number of additional species have been collected from this formation on the Ithaca quadrangle where it is favorably exposed about the head of Cayuga lake.

From Lake Erie eastward as far as Seneca lake the Cashaqua shale succeeds the black Middlesex shale and is overlaid by another band of black shale known as the Rhinestreet black shale, a formation that reverses the usual order and decreases in thickness toward the east and is not recognized with certainty in the Cayuga lake valley. Both these formations are absent in the Genoa district. Near the south line of the Genoa quadrangle the basal layer of the Cashaqua is a compact sandstone nearly 3 feet thick that thins out toward the north and disappears in a few miles but the contact is still plainly marked by the abrupt change in the color of the rocks.

Hatch shales and flags

This formation as exposed on the slopes of Hatch hill in the Canandaigua lake section is clearly defined by the Rhinestreet black shale upon which it rests and the Grimes sandstones by which it is overlain. It there, as here, consists of shales and thin sandstones in frequent alternations, but is thinner and less arenaceous, and though it contains a few fossils, they all belong to the Naples fauna from which brachiopods are, with the exception of a small Lingula, entirely absent.

In the Seneca lake section these beds are found to contain a few brachiopods and the lamellibranchs and cephalopods of the Naples fauna are less common. In the Cayuga lake valley, and specially in the southern part, the number of species of brachiopods and lamellibranchs that are not known in the horizon of these beds in the Naples or Genesee river section is greatly increased, while the representatives of the Naples fauna have almost, though not quite, disappeared.

The thickness of this formation on the Genoa quadrangle is 350 to 375 feet, lack of favorable exposures making precise measurement impracticable. The numerous exposures of this formation about Ithaca 6 to 10 miles south of the Genoa quadrangle have afforded about 50 species of fossils constituting the well known Ithaca fauna.

On the Genoa quadrangle exposures are less favorable, and the beds apparently less fossiliferous.

The collector may expect to find:

Stictopora meeki *Nicholson*
Aulopora *sp.*
Spirifer mesacostalis *Hall*
S. mesastrialis *Hall*
Cyrtina hamiltonensis *Hall*
Leptostrophia perplana *var.* nervosa *Hall*
L. mucronata *Hall*
Productella speciosa *Hall*
Ambocoelia umbonata (*Conrad*)
Schizophoria impressa *Hall*
Pugnus pugnax *Martin*
Camarotoechia eximia *Hall*
Cryptonella eudora *Hall*
Atrypa reticularis *Linné*
Chonetes scitulus *Hall*
C. lepidus *Hall*
Liorhynchus mesacostale *Hall*
Buchiola retrostriata (*von Buch*)
Microdon bellistriatus *Hall*
Schizodus chemungensis *Hall*
Modiomorpha subalata *var.* chemungensis *Hall*
Nucula diffidens *Hall*
Palaeoeilo constricta (*Conrad*)
P. filosa (*Conrad*)
Grammysia subarcuata *Hall*
Spathella typica *Hall*
Bellerophon leda *Hall*
Orthoceras bebryx *var.* cayuga *Hall*
Gomphoceras tumidum *Hall*
Bactrites aciculum (*Hall*)
Plumalina plumaria *Hall*

There are good exposures of these beds along Trumansburg creek from ¾ mile below the Lehigh Valley Railroad bridge to half a mile west of the village. The lower beds may be seen along Taghanic creek below Halseyville, and 15 feet of fossiliferous shale are exposed below the dam at Waterburg.

There are a few field outcrops of Hatch flags on the ridge between the Cayuga lake and Salmon creek valley, and along the east line of the quadrangle, but they are all small and insignificant.

Grimes sandstones

In the Naples quadrangle the Hatch shales and flags are terminated by the Grimes sandstones, a well defined formation composed principally of thick sandstones in which several species, members of the Ithaca fauna and mostly brachiopods, make their first appearance, making the formation important paleontologically as well as stratigraphically.

The Grimes sandstones are not exposed on this quadrangle but their position is approximately indicated from exposures at the west and south.

West Hill flags and shales

This formation is composed of thin sandstones and shales having an aggregate thickness of about 600 feet. It contains a mixed fauna embracing species belonging to the Naples and the Ithaca faunas, but is but moderately fossiliferous.

The surface rocks in the southwest corner of the Genoa quadrangle are in the lowest part of this formation, but they are covered by a thin drift mantle.

For further description of the Grimes sandstones and West Hill flags and shales see State Museum Bulletin 63.

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New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

PUBLICATIONS

Packages will be sent prepaid except when distance or weight renders the same impracticable. On 10 or more copies of any one publication 20% discount will be given. Editions printed are only large enough to meet special claims and probable sales. When the sale copies are exhausted, the price for the few reserve copies is advanced to that charged by second-hand booksellers, in order to limit their distribution to cases of special need. Such prices are inclosed in [ ]. All publications are in paper covers, unless binding is specified. Checks or money orders should be addressed and payable to New York State Education Department.

Museum annual reports 1847–date. *All in print to* 1894, 50c *a volume,* 75c *in cloth;* 1894–*date, sold in sets only;* 75c *each for octavo volumes; price of quarto volumes on application.*

These reports are made up of the reports of the Director, Geologist, Paleontologist, Botanist and Entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904–date.

1904. 138p. 20c.
1905. 102p. 23pl. 30c.
1906. 186p. 41pl. 35c.
1907. 212p. 63pl. 50c.
1908. 234p. 39pl. map. 40c.

These reports cover the reports of the State Geologist and of the State Paleontologist. Bound also with the museum reports of which they form a part.

Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, 8vo; 2, 14–16, 4to.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899–1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837–41, are out of print.

Reports 1–4, 1881–84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	17	$.75	21	$.40
14	.75	18	.75	22	.40
15, 2v.	2	19	.40	23	.45
16	1	20	.50	[*See* Director's annual reports]	

Paleontologist's annual reports 1899–date.

See first note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901–3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–20 bound also with museum reports 40–46, 48–58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3–4, 17 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	10	$.35	18 (Bul. 64)	$.20
2	.30	11	.25	19 (" 76)	.15
5	.25	12	25	20 (" 97)	.40
6	.15	13	*Free*	21 (" 104)	25
7	.20	14 (Bul. 23)	.20	22 (" 110)	.25
8	.25	15 (" 31)	.15	23 (" 124)	.75
9	.25	16 (" 36)	.25	24 (" 134)	.35

Reports 2, 8–12 may also be obtained bound in cloth at 25c each in addition to the price given above.

Botanist's annual reports 1867–date.

Bound also with museum reports 21–date of which they form a part; the first Botanist's report appeared in the 21st museum report and is numbered 21. Reports 21–24, 26, 31–41 were not published separately.

Separate reports for 1871–74, 1876, 1888–98 are out of print. Report for 1899 may be had for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), in volume 4 of the 56th (1902), in volume 2 of the 57th (1903), in volume 4 of the 58th (1904), in volume 2 of the 59th (1905), 60th (1906), in volume 2 of the 61st (1907) and 62d (1908) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887–date. 8vo. *To advance subscribers, $2 a year or $1 a year for division* (1) *geology, economic geology, paleontology, mineralogy; 50c each for divisions* (2) *general zoology, archeology and miscellaneous,* (3) *botany,* (4) *entomology.*

Bulletins are grouped in the list on the following pages according to divisions.

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—— & Clarke, John M. v. 8 pt1 Introduction to the Study of the Genera of the Paleozoic Brachiopoda. 16+367p. 44pl. 1892. $2.50.

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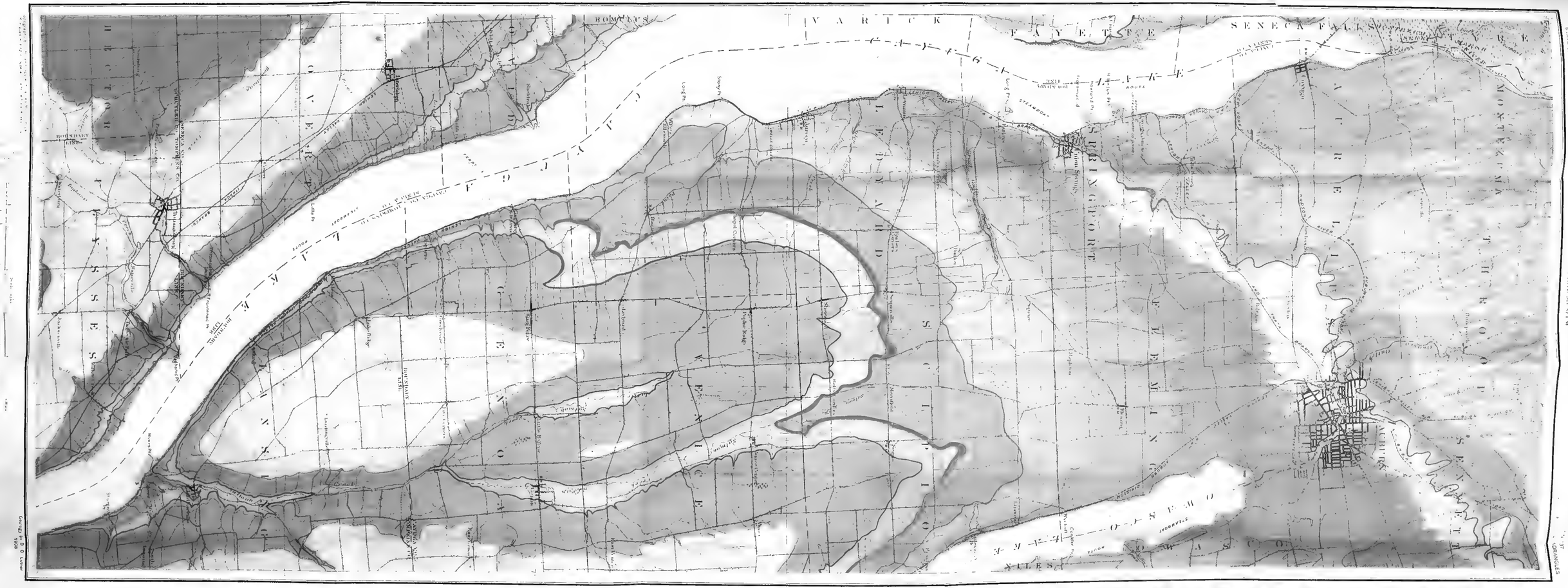
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